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VIEWPOINT

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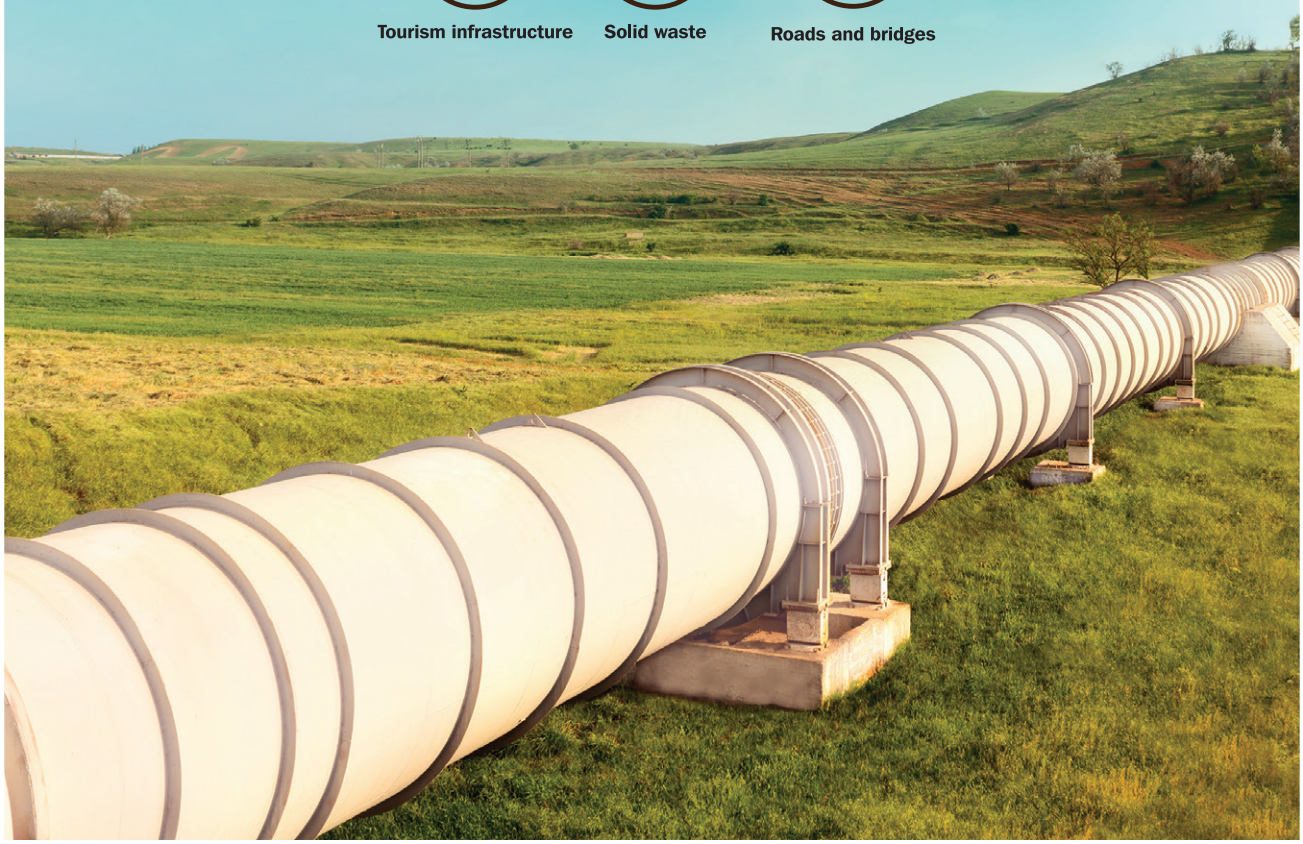

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Message from Chief Editor

Dear Fellow Consulting Engineers & Readers,

The coming months hold promise of respite from the regime enforced for over a year. With the monsoons expected to be normal in most parts of the country the economic conditions also look bright. To be able to say that for all the engineering works being done would be a possibility when the hazards and the consequential risks associated with them are duly and fully considered and provided for. The monsoons usher in good tidings but in their wake also cause disasters in some areas.

The two cyclonic storms that affected India and its neighbours in May 2021 - Cyclone Tauktae and Cyclone Yaas were tracked and warnings given well in time. Those who heeded the warnings remained safe but for those who did not the end was different. India has ramped up its meteorological data gathering, forecasting and tracking capabilities considerably but much more could be done to predict local area occurrences. Similar capabilities need to be developed for other natural phenomena such as tectonic movements, earthquakes, landslides, glacial melting, glacial movements, avalanches, etc. All are not easy nor cheap but most are doable with the help of IoT and satellite monitoring. The decisions should be guided by long term effects and the savings that would accrue. However, the fact that some phenomenon is being monitored should not form the basis of works to be executed or habitations springing up haphazardly in that area. Lessons must be learnt from the past disasters. No development is worth except for strategic defence purposes in disaster prone areas and for them the monitoring of natural phenomena should be done even more critically.

Disaster is normally associated with a natural phenomena but could be equally well be caused by a building, structure, machine, equipment, industrial or a process plant (oil& gas, chemical, pharmaceutical, bio-chemicals, etc.). While hazard and risk identification and assessment has picked up in the process plant industry it has still to become a part and parcel of the others.

It is necessary that Risks are identified as a matter of routine in all walks of life and especially so in professional works and businesses, especially engineering or else the outcome could be catastrophic. This exercise must be done by Engineers and Strategists to ensure that what they do is safe, sound and robust and that the results/ yield would be as planned. To create general awareness on these points CEAI had held a webinar on “Hazards & Risks”, a report of which is given in this issue.

Indian Consulting Engineers must use the latest that science and technology can offer to set the pace for development in India and also assist other countries.

Engineers Must Assess & Mitigate Risks

A P Mull

Risk, Risk Management and Resilience

Rajeev Dhanvantray Tanna
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Introduction

The word "Risk" is normally associated in one's mind as the possibility of a negative event. However, when the term "Risk" is used in an organizational management context, the connotation is not exclusively negative. The globally accepted standard on Risk Management ISO:31000 defines risk as the "effect of uncertainty on objectives" – indicating that risks could either be negative (downsides of risk or threats) or positive (upsides of risk or opportunities).

Historically, Risk Management in organizations initially focussed on hazard risks (or insurable risks) like fire, accidents, theft, etc. and their mitigation; then moved on to financial risk management and eventually to cover the entire gamut of risks faced by an organization.

Resilience in the corporate world could be defined as the ability or capacity of an organization to withstand and recover quickly from difficult situations or disruptions. Organizations across the globe had and are having their resilience severely tested by the sudden disruption and large number of uncertainties posed by the Covid-19 pandemic.

Major infrastructure and manufacturing activities are usually executed through projects. In such projects the typical life-cycle starts with the prospecting and bidding activities and ends in commissioning of the plant or facility and its operation.

In this article, an attempt is made to highlight risks from some specific areas that could impact a project through its life-cycle from prospecting to operations and how

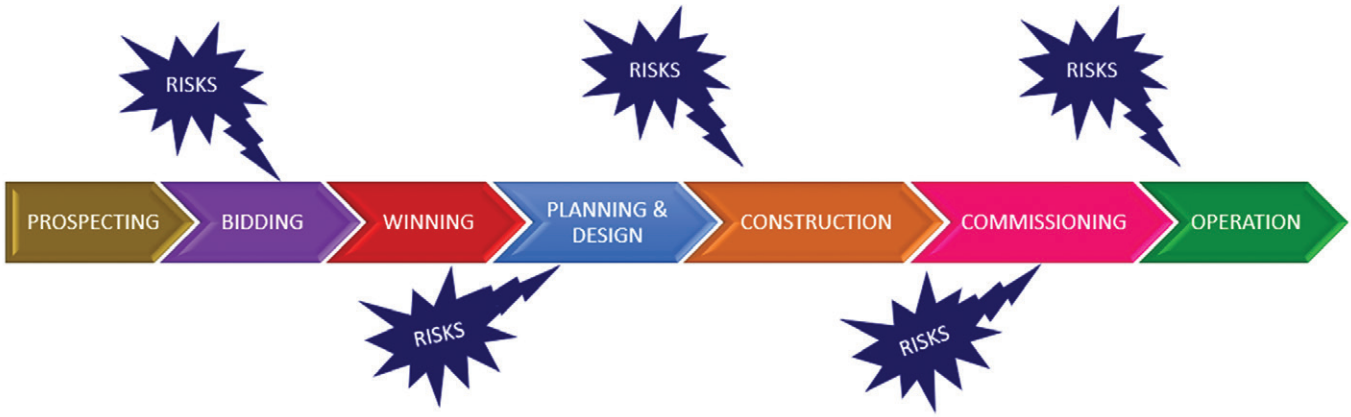


Figure 1: Typical lifecycle of a project

risk response measures are implemented to ensure resilience. The risks if identified at an early stage can help one to plan for the risks at the Design Stage itself. Alternatively, if risks are identified or experienced across subsequent stages, one has to depend on its risk resilience mechanism or alternatively build mitigation measures post facto which could come at substantially higher cost.

Risks associated with external hazards can include risks from natural hazards like earthquake, cyclones, floods, etc. Risks can also arise from man-made causes like terrorism, labour strikes, water management, and cyber-crime in addition to risks arising from developments on the technology front. All these risk areas can have severe impacts on Project Objectives.

Natural Hazards

Earthquake, cyclones, floods, storms, tsunami, landslides, avalanches, droughts, forest fires, climate change, etc. are among the most devastating types of natural catastrophe. Instances of such hazards impacting projects and operations are of course many.

Fukushima, Japan[1]

On 11th March 2011, a 9.0 magnitude earthquake - known as the Great East Japan Earthquake, or the 2011 Tohoku earthquake - struck east of the city of Sendai, 97km north of the Fukushima nuclear plant. The quake triggered a tsunami which swept over the main island of Honshu, killing more than 18,000 people and wiping entire towns off the map.

At the Fukushima nuclear power plant, the resultant 14-metre wave surged over defences and flooded the reactors, sparking a nuclear meltdown and also a number of chemical explosions. Radioactive material began leaking into the atmosphere and the Pacific Ocean, prompting the evacuations and an ever-widening exclusion zone. Long-term effects of the radiation are a matter of debate.

Gujarat Earthquake 2001[2][3]

On 26th January 2001, there was a powerful earthquake measuring 6.9 on the Richter scale with epicentre at 20 km North East of Bhuj in the state of Gujarat. The most affected areas districts were Kachchh, Ahmedabad, Jamnagar, Rajkot and Surendranagar. The quake caused extensive loss of lives, property and infrastructure. The death toll was around 20,000. The total estimated loss including houses, infrastructure, industrial structures, etc. was estimated to be Rs. 21,262 crores. Two ports,

Kandla and Navlakhi, and some industrial plants suffered significant damage.

Damage to the railway line feeding Navalakhi port

Damage at Sikka Cement Works

Risk Response Measures for Natural Hazards

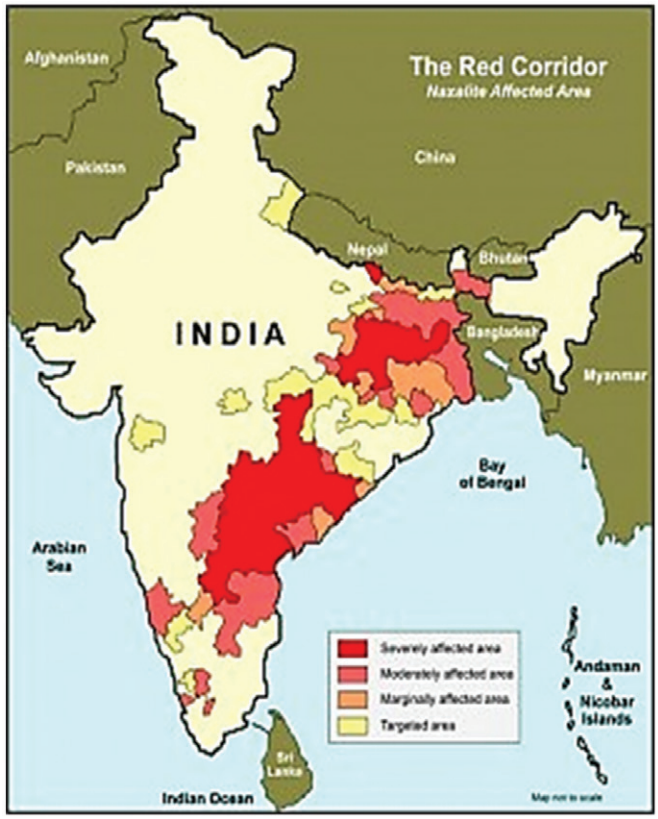
- During the project conceptualization stage, appropriate studies, secondary data collection and analysis are carried out to assess potential risks from natural hazards like earthquake, etc.
- During planning and design stage, the data collected is utilized to build in adequate protection to ensure the resilience of the plant in the face of such hazards. While the approved design codes prescribe factor of safety which are revised as more experience is gained, the owner or consultant could additionally specify extra levels of protection.
- As per reports, the foundations in Jamnagar Refinery were designed to withstand an earthquake that measured 8 on the Richter scale although earthquakes with intensity of more than 5.5 had not been experienced in that area for the past 75 years.

Man-Made Hazards

Terrorism, Water Management issues, Cyber-attacks, Pollution, etc. are examples of man-made hazards which could have a substantial impact on projects and operations. Some examples:

Terrorism & Insurgency

In the Indian context, insurgent organizations are to be reckoned with by the government as well as private companies executing projects in regions where they exist. There have been cases of kidnapping officials, owners, employees, etc. for ransom. Several public utility projects have been delayed due to local disturbance. The problems posed by Naxals in the 'Red Corridor' are well known.



Cyber-crime

An article on the website of anti-virus company McAfee[5] lists the cyber threats in the Energy Sector:

- Stuxnet malware targets the Programmable Logic Controllers (PLCs) used to automate machine processes. It generated a flurry of media attention after it was discovered in 2010 because it was the first known virus to be capable of crippling hardware. Stuxnet reportedly destroyed numerous centrifuges in Iran's Natanz uranium enrichment facility by causing them to burn themselves out.
- One in four power companies globally have been victims of extortion
- 60% of power companies in India have been victims
- Extortion is the most prevalent cyberthreat reported by the global energy sector

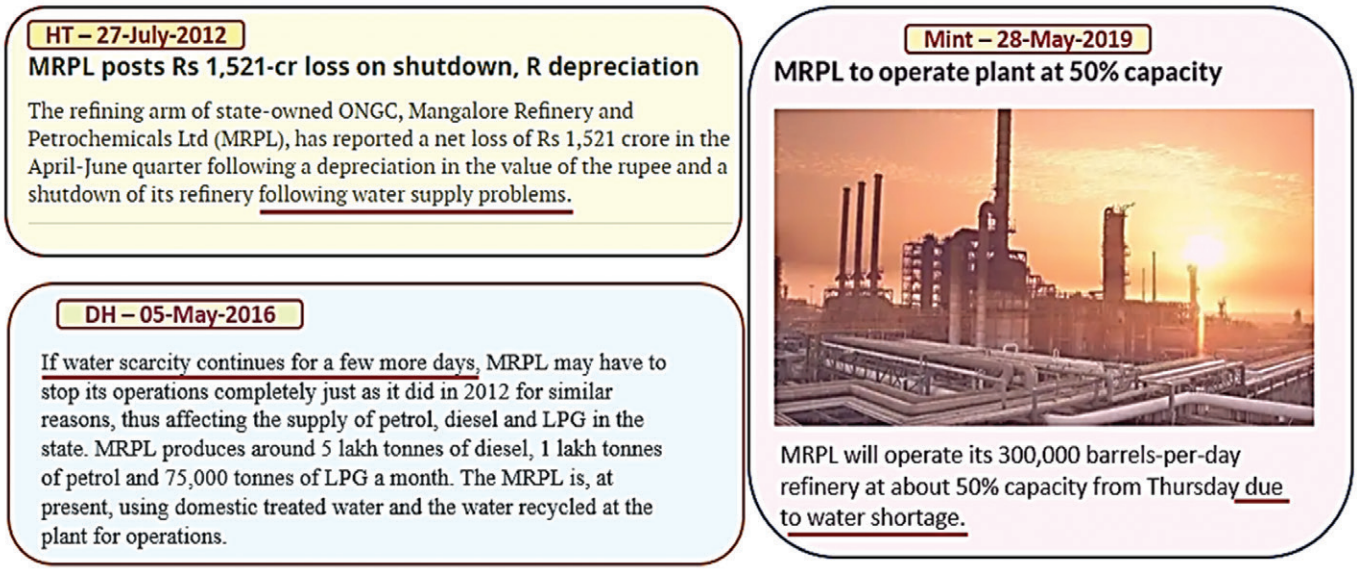
Droughts and Water Supply Problems

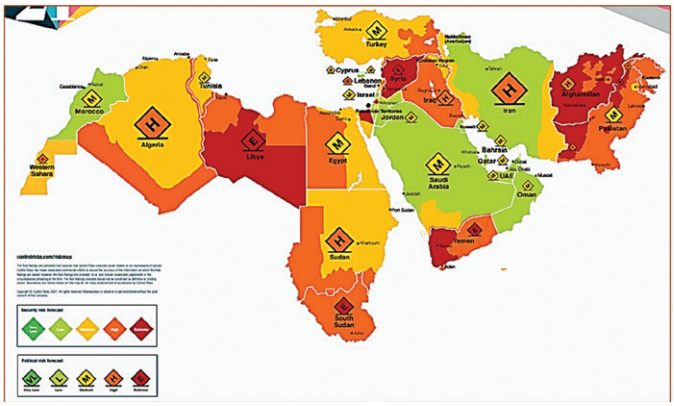
The news clippings above show how shortage of water can cripple the operations of a huge project like the Mangalore Refineries & Petrochemicals Ltd. and convert the forecasted profits of thousands of crores of investment to losses.

Risk Response Measures for Man-made Hazards

As for natural hazards, proper data collection and analysis during the project conceptualization or bidding stages can help to identify many of the potential risks. The following need to be kept in mind:

- For linear projects like cross-country pipelines, electricity transmission lines, highways, etc., the threats along the entire stretch of the proposed project should be studied.
- The project itself may be quite far from localized problems like the Naxalite affected regions, but the critical supply chains may be passing through such areas – these should be evaluated and alternate options should be identified to be activated should the risk materialize.
- To avoid the problems like the water shortage issue, sufficient future projections should be made, and alternate methods considered in the planning stage itself. In the MRPL case, a water desalination plant was planned later to build risk resiliency.
- For cyber threats, continual evaluation of threats and updation of the various protection measures including raising awareness of the users combined with adequate back-up of data and facilities is a must to ensure resilience.

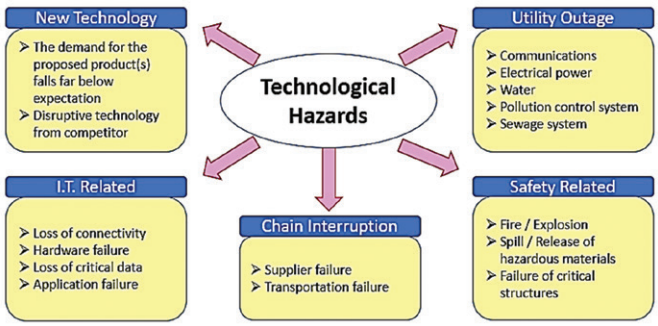




- While planning for projects in overseas locations, it is recommended to carry out studies to understand the country / location risk profile. Risk ratings by professional agencies like Control Risks (e.g. Risk Map 2021 for MENA region shown below) as well as travel advisories issued by government agencies could also be referred.

Technological Hazards

The rapid advances in technology, global supply chains, dependence on information technology, lack of focus on asset reliability, etc. have made companies more susceptible to uncertainty and risk. Technological hazards could be considered a subset of man-made hazards. Technological hazards can also result directly from the consequences of an event related to natural or man-made hazards.



Deepwater Horizon rig fire, explosion and oil spill

Sinking of the Deepwater Horizon Oil Rig and subsequent Gulf of Mexico oil spill, was and remains the largest marine oil spill in history. This was caused by explosion on the Deepwater Horizon oil rig, on April 20, 2010, located in the Gulf of Mexico, off the

coast of Louisiana. The rig was owned and operated by offshore-oil-drilling company Transocean and leased by oil company BP. 11 workers died in the explosion and resulting in estimated leakage of 100,000 gallons of oil daily.

The petroleum that had leaked from the well before it was sealed formed a slick extending over more than 57,500 square miles (149,000 square km) of the Gulf of Mexico. This oil leakage had a huge negative immediate and long-term impact on marine life. Thousands of birds, mammals, and sea turtles were plastered with leaked oil. It also impacted sectors of industry like fishing, tourism and hospitality, thus affecting livelihoods of thousands of families.

Effects of the oil slick: (L) Beach being cleaned & (R) Pelicans coated with oil

The owners, lessees and contractors connected with the Deepwater Horizon oil rig Transocean, BP and Halliburton had to pay out billions of dollars as legal penalty, costs of capping the well and cleaning operations and other related costs. These companies also suffered considerable loss to reputation and business.

Risk Response Measures for Technological Hazards

- Technological and supply chain feasibility studies in project conceptualization stage
- Agility in processes ensured at design stage to adapt to rapidly changing demand scenarios.
- Robust IT security and back-up systems ensure resilience on the critical IT front.
- Developing and maintaining high SHE standards

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Reduce Mishaps, Says Nitin Gadkari

Mr Gadkari said that his aim is to achieve 50 per cent reduction in road accident deaths and zero accidents and deaths by 2030.

Government has mandated safety audits at all stages of road development to reduce accidents, as India along with other developing countries has a high rate of road mishaps.

Minister for Road Transport and Highways Nitin Gadkari said this on Monday while inaugurating a programme on vehicle crash safety. He added that safety audits have been made mandatory as around 1.5 lakh people are killed annually in India, a figure which is even higher than Coronavirus related deaths.

Mr Gadkari said that his aim is to achieve 50 per cent reduction in road accident deaths and zero accidents and deaths by 2030.

He further said that around 60 per cent deaths are of two-wheeler riders and therefore protection and safety of motorcycle traffic is the need of the hour.

The minister stressed on the importance of training of drivers and establishment of advanced training institutes and centres.

https://www.ndtv.com/business/safety-audit-mandatory-for-road-project-to-reduce-mishaps-says-nitin-gadkari-2479887

Mitigating Pandemic and Climate Change Challenges

Pradeep Chaturvedi
Chairman, Interdisciplinary Coordination Committee
Institution of Engineers (India)

The United Nations and the Government of India have been emphasizing on over coming climate crises through resilient systems and processes – that is a big challenge to the engineering community and businesses. The genetic structure of the virus (SARS-CoV-2) was sequenced within weeks of its discovery, and it was done with the help of both scientist and engineers. Electronics, Electrical, Mechanical, Computer, and Chemical engineers were all involved in making that possible. Another area where engineers are playing a role is in the scale-up of production of vaccines and medical equipments and accessories. Engineers have developed software and interpretive systems to ensure working on the virtual platform with utmost efficiency. A large number of sophisticated engineering based start-ups have communicated effectively and produced innovative systems with inbuilt resilience and response to the identified risks.

The resilience that businesses have developed in the face of disruption can provide a new foundation for growth – provided leaders seize the moment to build on what their people have achieved. They need advice from outside agencies with latest professional acumen. Management Consulting Companies are doing roaring business, advising on strategy for growth.

Operations Functions are Important

Operations functions – including procurement, supply chain, and manufacturing – are at the forefront of managing the challenges and finding new ways of working in the light of global trends and disruptions. The Covid-19 pandemic has accelerated the pace of change, creating an inflection point. Companies have relied on their operations functions not only to maintain day-to-day operations, which has itself been challenging, but also to position the business to survive and grow in the post-pandemic world.

The pandemic is the latest, and most severe, disruption to affect value chain in recent times. The financial impact of these disruptions is significant. MGI analysis found that over the course of a decade, the average company can expect disruptions to cause losses equal to almost 45% of one year's profit.

As many companies have realized over the past year, many operations and functions were not sufficiently prepared to handle the shocks. These functions were built for the earlier non-digitalisation era, when change was more gradual, disruptions were less frequent, and customer expectations were lower. Today, companies need greater transparency into demand, supply chains, and production capabilities, so that they can respond proactively or in real time to rapidly changing conditions.

On the other hand, these disruptions are also leading to growth. In the consumer-goods industry, for example e-commerce experience the equivalent of ten years growth in the first three months of the pandemic.

Considering that operations disruptions – whether arising from geopolitics, technology, climate change, or disease – are becoming easily frequent, incremental improvements will not be sufficient to prevent significant revenue losses. Operations leaders must fully re-think their organizations and capabilities to deliver not only short-term financial improvement, but also longer term value creation through efficiency, resilience, agility and digitalisation.

Engineering consulting companies involved also have to have a different outlook. They need to understand the similarities in operations and processes in the value chain. And improve their skills and capabilities of upscaling operations, introducing new technologies, reskilling and upskilling at a quick pace by digitalization so as to provide better services to their clients so that both gain and prosper. The digital gap between engineering companies and the clients is widening due to digitalisation. Earlier, this was being ignored, but now the gap is being narrowed. IoT has changed the world and even persons in low income groups are embracing it.

The Challenges also Hold Potential

Cost efficiency remains a perennial challenge. Ongoing price erosion has increased pressure on organizations to better manage their cost and cash position and rapidly improve the bottom line. The need for action is particularly strong in technology and advanced industries (such as semi-conductor) which have experienced price erosion of 5% to 20% annually in recent years. Moreover, in several industries the pandemic changed or eliminated sources of revenue virtually overnight. Have the consultants kept their hand on the nerve of their clients? The answer is simply No. Even with effective digital connectivity they are not keeping in touch in real time. They need to gear up fast to meet the challenges.

At the same time, resilience has gained equal importance alongside cost efficiency as a driver of operations related decisions. The pandemic has exposed global operations to new risks related to manufacturing and supply chain, such as the increased regionalisation of production and supply. And, these factors have a direct impact on infrastructure and construction projects. The need to comply with international trade restrictions and other regulations (such as for data privacy) has created incentives for companies to consider slowing, or even reversing, some part of globalisation of the past few decades. But this has turned into an incentive for self-reliance and Atam Nirbhar Bharat.

To achieve their goals for cost efficiency and resilience, companies are working to become more agile in responding to fluctuation to demand and supply – a quality that will also help companies to service growth in demand as economies and customers start to recover from the pandemic. The need for agility has made it essential for operations functions to connect more closely with commercial teams, so that both sides can deepen they visibility into demand, assess scenario, and undertake mitigating actions as needed.

Is Digital Technology a Boon?

The adoption of digital technology provides opportunity to companies to promote efficiency, resilience, and agility. The pandemic has accelerated the digital transformation of organizations at an unprecedented pace, as companies head to pivot quickly to serving their customers remotely and establishing virtual work places for their employees.

McKinsey and Company the leading management consulting group has identified that the effort to rethink operation in the new normal has to be guided by few imperatives: Rethink the supply – chain vision to enable agility; to improve customer-centricity, and resilience. Companies can reshape their supply chain to respond in an agile way to changes in both customer demand and supply, and evaluation that will rest on a customer-centric vision in which processes and priority are aligned to demand trends. It requires segmenting the customer base so that the company can cater to each segment's distinctive needs. Customer-centricity

is to be supported by rigorous scenario planning, in particular for 'high-importance' or 'high-margin' products. This concept is significantly important for consultants while choosing the technology.

The most glowing example on supply chain management comes from the chaos created in Delhi on issue of oxygen supply during the second wave of Covid. Many of the experts had challenged assumptions made by Delhi Government where they were asking 1200 MT of oxygen supply to meet the peak demand in Delhi. Irresponsible and unscientific approach only misled the Government to make such high demand and deprive other regions of oxygen supply. Expert audit subsequently has brought out this fact and presented to The Supreme Court. Therefore, these figures can't the challenge. Here is a case where need assessment for oxygen supply was not appropriately carried out and also the resilience in the system was not factored-in. When the Delhi Government took action and involved experts of Indian Institute of Technology Delhi and other leading professional organisations they could develop a software where supply management changed virtually overnight and the general public in Delhi was relieved of all agony. Engineers and engineering professional consulting organizations have played an important role in finding out these solutions.

Climate Change and Role of Businesses

The private sector is deeply involved with the various government and international agencies to support measure to mitigate climate change effects. On November 5, 2020, 24 leading companies worldwide signed the "Declaration of the Private Sector on Climate Change" to tackle the climate crises. This was an important beginning as the private sector will have to play a crucial role in mobilizing resources, knowledge and innovation. And within the private sector, family controlled conglomerates are uniquely positioned to lead the low or no carbon growth trajectory. Reliance has recently announced a Rs. 75,000 Crore initiative to start manufacturing, supply, installation and storage of renewable energy systems, mainly solar. They have also announced that by 2030 they will add 100 GW of solar systems. Presently, India has the third highest number of public-listed, family controlled companies in the world after China and United States. 15 of the BSE Sensex – the index of 30 reputed companies listed on the Bombay Stock Exchange – are family controlled, accounting for more than half of the Sensex combined market capitalisation. Share price returns of family businesses have also consistently outperformed non-family owned firms.

Reasons why a family conglomerate can take high level of investment decision is its unique structure unlike other corporates, Family businesses are organised around a patriarch who bears the ultimate responsibility and holds the final decision making power. Though the professionalisation of family businesses has resulted in hiring competent executive to advise and assist, they still run at the will of the founder or his appointed successor.

To avert a crisis of like climate change, forward thinking and long term planning are required, for which the value of committed visionary leadership cannot be under estimated. As family conglomerates are organized around visionaries, if they sincerely act on the climate crises, they can change the trajectory of their own business and depth of carbon intensity of the sector rapidly.

It has been observed that just seven family conglomerates (Reliance, Adani, Tata, Aditya Birla, Mahindra, Jindal and Vedanta) are responsible for anything about 530 Million Tons of carbon-dioxide annually. This is equivalent to 22% of India's total carbon-dioxide emissions. In 2019-20, these 7 groups operated 25% of India' coal based power plants (50,000 MW). If these companies get serious about climate action, India's emission profile will look fundamentally different. While this seriousness primarily comes down to the business argument, evidence that family business take a more long term view on innovation and investments than non-family businesses and assure quicker action on decarbonisation and mitigating climate effect.

Conclusion

The engineering consultancy companies worldwide have helped the different groups in attaining the capability to fast restart the economy. Many of those who are involved in the infrastructure projects reflect about the difficulties faced during the Covid period keeping in view the systems followed in pre-Covid days. Some of the smarter consultancy groups have totally switched over to digitalisation and are making higher profits than in pre-Covid days. If some of the innovative and enterprising consulting companies have shown the way then others should also refine their operations/ processes and make themselves Future-Ready.

India's engineering, research, development market to reach USD 63 bln by 2025: Nasscom

India's share in the global engineering and research and development (ER&D) market is expected to grow at a compound annual growth rate (CAGR) of 12-13 per cent to reach USD 63 billion by 2025, according to industry body Nasscom.

Speaking at the Nasscom Engineering R&D Showcase 2021 event, Nasscom President Debjani Ghosh noted that the pandemic has altered the way consumers behave, interact with companies, and how businesses interact.

Contactless technologies, analytics, software-led systems are changing how products are designed, redesigned, engineered, and consumed, she added.

"...this represents a very unique opportunity for the ER&D companies in India that are primarily focusing on product design and innovation to partner with global enterprises and engineer the future, global megatrends like sustainability, create even more opportunities for product redesign and innovation and that is going to be tremendously important for the future of this industry," Ghosh said.

She said India's share in the global engineering and research and development (ER&D) market is expected to grow at a CAGR of 12-13 per cent to reach USD 63 billion by 2025 from USD 31 billion in 2019.

"This growth is being driven by global enterprises across automotive, aerospace, consumer electronics, medical devices, industrial and energy, semiconductor, telecom who are tapping into Indian ER&D's ability to power innovation, drive high impact service delivery by leveraging the think force of the future," she added.

https://economictimes.indiatimes.com/industry/indl-goods/svs/engineering/indias-engineering-research-development-market-to-reach-usd-63-bln-by-2025-nasscom/articleshow/83815002.cms

A Study of Change in Employee Perceptions about Organizational Risk and Resilience Processes During Covid-19 Pandemic Times

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ABSTRACT

Risk management has become an integral part of organizational strategy and operations as a consequence to the events that have occurred in the twentieth and twenty first century which have underlined the need for robust organizational risk management functions. Businesses exist due to their ability to undertake measured and calculated risks. Thus, managing risks is a critical element of managerial responsibilities. It is not only business continuity and sustenance plus the growth over a prolonged period demand robust risk planning and risk mitigation plans at the organizational level. Some profound challenges necessitate fundamental relook at organizational risk management and resilience. The current COVID-19 pandemic is a major challenge that is testing organization's resilience in multiple dimensions. This paper articulates the learnings in the areas of organizational risk and resilience during the COVID-19 pandemic period. The paper also discusses the employee survey analysis to evaluate the impact on organizational resilience through different initiatives taken during the COVID-19 pandemic period.

1. Introduction

Widely used definition of disaster was coined by McFarlane and Norris as "a potentially traumatic event that is collectively experienced, has an acute onset, and is time delimited; disasters may be attributed to natural, technological or human causes". In a paper on the topic of Managing Risk and Resilience, authors Van Der Vegt et al. (2015) discussed key aspects of risks faced by modern organizations and societies in the interconnected world. They argued that organizations form a critical bridge between individuals and the societies at large. The daily lives of people are increasingly dependent upon how different organizations work internally and interact with other organizations. Such interconnected behaviour decides how effectively societies can manage a risk and display resilience.

In a complex interconnected world like todays, risk management continues to be a crucial function. However, there are shortcomings in the form of inadequate identification of risks and ill-preparation of risk mitigation plans. As many seemingly unrelated risks are combining in a space and time, they can snowball into a grave risk that usually gets missed out through a conventional risk identification mechanism.

Hence, the focus is slowly shifting towards an organization's ability to not only absorb the shocks in the best flexible ways but to display the capability to bounce back after such shocks. Various aspects of the resilience at the organizational level have been identified and elaborated viz. organizational structure and decision making, coordination within and across organizations and governance, etc. Societies can be resilient if individual and interconnected organizations are built upon the resilience principles.

Park J. & Seager, T.P. et al. (2015) stress upon importance of differentiating resilience from the traditional way of risk management exercise. They argue that there are three main limitations in the engineering risk analysis:

1. Usually engineering challenges are defined as problems to be solved rather than conditions to be managed.
2. Over emphasis on cost reduction diverts attention from pragmatic way of devising engineering solutions.
3. Due to mandates from government agencies and subsequent adaptation of industry bodies, the engineering design exercise becomes a slow adapter to face fast emerging challenges.

As engineering systems are getting more complex, interdisciplinary factors are coming into play. By trying to pack more functionalities at competitive prices, the systems are getting increasingly optimized leaving lesser margin for adaptation in times of adversities. The authors suggest four key elements of resilience thought process viz. Sensing, Anticipation, Adaptation and Learning.

The second i.e. the next section describes the research methodology, data collection, data analysis and hypothesis testing. The third section discusses the research findings and the fourth, i.e. the last section provides the conclusions and directions for future studies.

2. Research Methodology

The subject of risk and resilience is a widely researched topic. The topic is of interest to researcher as is evident from the high number of research articles published in various academic and research journals of repute. As the COVID-19 pandemic is still evolving, there is a dearth of articles on risk and resilience vis-à-vis the COVID-19 pandemic. This paper is intended to partially bridge this gap through a quantitative research. A single case study is adopted as a research methodology. An online survey tool was deployed to gather the primary data.

The sudden onslaught of the COVID-19 pandemic took the organizations around the globe by surprise. The sudden and drastic shift from 100% work from office to 100% work from home tested organizational preparedness from a risk and resilience perspective. Organizations took steps to gauge and then mitigate risks arising out of widespread and sudden disruption. The study was conducted to check the effectiveness of such steps.

2.1. Research Hypotheses

An Indian organization engaged in the Engineering consulting and design was chosen to undertake such study. The organization is active in both domestic (Indian) and international markets. Its delivery teams are spread across different development centres in India and business development teams operate from various geographical regions outside India too. The organization is structured around the Strategic Business Unit (SBU) concept.

The interest of the study was to evaluate the effectiveness of the steps taken. Seven (7) research hypotheses H1 to H7, covering different aspects were formulated on the premise that "There was no change in Employee perception During COVID-19 pandemic period and the Pre-COVID-19 pandemic times" for:

Hypotheses Related to Risk Management

A. Hypothesis H1: 'Project Planning and Work Distribution Process'
B. Hypothesis H2: 'Project Execution Process'
C. Hypothesis H3: 'Project Review Process'

Hypotheses Related to Resilience

A. Hypothesis H4: 'Teamwork'

B. Hypothesis H5: 'Communication Process'

C. Hypothesis H6: 'Performance Appraisal Process'

D. Hypothesis H7: 'Training Process'

2.2. Data Collection

A pilot questionnaire was prepared, and a dozen employees were requested to respond. The data consistency of response was checked and feedback about the questionnaire wording was sought. The necessary changes were made in the sequencing and wording of questionnaire to avoid ambiguity. The online survey was then sent to employees engaged in project delivery work. The response to each question was sought for both Pre-COVID-19 and During COVID-19 periods. The response scale was 5-point Likert scale. Response 3 indicated a Neutral response (Neither Agree nor Disagree), response 1 indicated Strong Disagreement while response 5 indicated Strongly Agreement. In all 180 employees responded to the survey and that formed the basis of the analysis.

Cronbach's Alpha is the measure of coherence of the survey test responses, i.e., which responses are fewer correlated to overall score.

The range of Cronbach's alpha remains between 0 and 1. Higher the value of Alpha, the more consistent is the data. Some literatures recommend considering the value for Cronbach's Alpha above 0.70. A reference table is enclosed below for different ranges of the Cronbach's Alpha with reference to test data consistency.

Table#1: Cronbach's Alpha with associated Data Consistency Ranges

Cronbach's Alpha	Data Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Table#2: Cronbach's Alpha for Survey Data for all Hypotheses

No	Categories	No. of Questions	Cronbach's Alpha	Internal Consistency	Remarks
1	Hypothesis:H1	3	0.792	$0.8 > \alpha \geq 0.7$	Acceptable
2	Hypothesis:H2	2	0.9281	$\alpha \geq 0.9$	Excellent
3	Hypothesis:H3	2	0.843	As $0.9 \geq \alpha \geq 0.8$	Good
4	Hypothesis: Overall; Managing of Risk	7	0.8684	As $0.9 \geq \alpha \geq 0.8$	Good
5	Hypothesis:H4	2	0.7786	$0.8 > \alpha \geq 0.7$	Acceptable
6	Hypothesis:H5	2	0.8471	As $0.9 \geq \alpha \geq 0.8$	Good
7	Hypothesis:H6	1	0.8764	As $0.9 \geq \alpha \geq 0.8$	Good
8	Hypothesis:H7	2	0.8439	As $0.9 \geq \alpha \geq 0.8$	Good
9	Hypothesis: Overall; Resilience	7	0.8554	As $0.9 \geq \alpha \geq 0.8$	Good

2.3. Testing of Hypotheses

2.3.1. Hypothesis Testing –Risk Management

2.3.1.1. Hypothesis H1: There was no change in Employee perception for 'Project Planning and work distribution Process' during COVID-19 pandemic period and pre-COVID-19 pandemic times.

The survey had 3 questions related to this topic. The Cronbach Alpha was calculated to ascertain the internal consistency of response. The value of 0.7492 was acceptable.

In a sample of (N=180), perception about 'Project Planning and Work distribution processes' significantly improved after a move from M = 3.9389 (SD = 0.8046) to M = 4.4019 (SD = 0.7044).

The changes were found significant as t (179) = - 9.1721 with df = 179, sig. (2 tail) = 1.9606, p(2-tail) = .0000

As the p (.0000) ≤ α (0.05), the null hypothesis got rejected Thus, it can be concluded that the employee perception about project planning and work distribution before COVI-19 period and during covid-19 period was significantly different.

The t-test analysis was carried out for remaining hypothesis of 'Risk Management' similar to H1 testing and results are given in Table#3.

Table#3: Testing of Hypotheses - *t* Test Statistics ('Risk Management')

		Mean	N	Std Deviation	Std Error of Mean	*t*	*df*	*t*-Critical Two Tailed	*p* (T≤ *t*) Two Tailed
1	**Hypothesis:H1**								
	Pre-COVID-19 pandemic period (PRE)	3.9389	180	0.8046	0.0600				
	COVID-19 pandemic period (DUR)	4.4019	180	0.7044	0.0525				
	(PRE-DUR)					-9.1721	179	1.9606	0.0000
2	**Hypothesis:H2**								
	Pre-COVID-19 pandemic period (PRE)	4.0361	180	0.7732	0.05763				
	COVID-19 pandemic period (DUR)	4.0753	180	0.8006	0.05967				
	(PRE-DUR)					-1.2802	179	1.9606	0.2021
3	**Hypothesis:H3**								
	Pre-COVID-19 pandemic period (PRE)	4.0167	180	0.8537	0.0636				
	COVID-19 pandemic period (DUR)	4.2556	180	0.7502	0.0559				
	(PRE-DUR)					-5.4141	179	1.9606	0.0000
4	**Hypothesis: Overall; Managing Risk**								
	Pre-COVID-19 pandemic period (PRE)	3.9972	180	0.6632	0.0494				
	COVID-19 pandemic period (DUR)	4.2444	180	0.6104	0.0455				
	(PRE-DUR)					-7.6208	179	1.9606	0.0000

2.3.2. Testing of Hypotheses–Resilience

The t-test analysis was carried out as similar to 'Risk Management' and results are given in Table#4.

Table#4: Testing of Hypotheses - *t* Test Statistics (Resilience)

		Mean	N	Std Deviation	Std Error of Mean	*t*	*df*	*t*-Critical Two Tailed	*p* (T≤ *t*) Two Tailed
5	**Hypothesis:H4**								
	Pre-COVID-19 pandemic period (PRE)	4.4222	180	0.7545	0.0562				
	COVID-19 pandemic period (DUR)	4.4611	180	0.7427	0.0554				
	(PRE-DUR)					-0.8185	179	1.9606	0.00012
6	**Hypothesis:H5**								
	Pre-COVID-19 pandemic period (PRE)	4.3629	180	0.6538	0.0487				
	COVID-19 pandemic period (DUR)	4.4704	180	0.6466	0.0482				
	(PRE-DUR)					-3.0428	179	1.9606	0.0027
7	**Hypothesis:H6**								
	Pre-COVID-19 pandemic period (PRE)	4.2778	180	0.7984	0.0595				
	COVID-19 pandemic period (DUR)	4.4333	180	0.6859	0.0511				
	(PRE-DUR)					-4.2265	179	1.9606	0.0000
8	**Hypothesis:H7**								
	Pre-COVID-19 pandemic period (PRE)	4.1944	180	0.6588	0.0491				
	COVID-19 pandemic period (DUR)	4.2111	180	0.6971	0.0520				
	(PRE-DUR)					-0.4487	179	1.9606	0.6542
9	**Hypothesis: Overall; Resilience**								
	Pre-COVID-19 pandemic period (PRE)	4.314	180	0.5606	0.0418				
	COVID-19 pandemic period (DUR)	4.393	180	0.5521	0.0412				
	(PRE-DUR)					-2.7008	179	1.9606	0.0075

Note: Where N, t, df, stands for survey sample size, t value worked out through t-test, degree of freedom (N-1)

2.3.3. The Summary of results of t-test

The summary of the results of the t-test for all the Hypotheses are given in Table#5.

Table#5: The Summary of results of t-test for all the Hypotheses

Sl. No	Risk/ Resilience	Hypothesis	Cronbach Alpha	t-test	Remarks
H1	Risk	Work distribution/ planning	**0.7492**	***p* (.0000) ≤ *α* (0.05)**	Significant changes are observed and hence Null Hypothesis is rejected
H2	Risk	Review Process	**0.8430**	***p* (.0000) ≤ *α* (0.05)**	Significant changes are observed and hence Null Hypothesis is rejected
H3	Risk	Project Execution	**0.9282**	***p* (.2021) > *α* (0.05)**	Significant changes are not observed and hence Null Hypothesis could not be rejected
Overall Manging of Risk			**0.8684**	***p* (.0000) ≤ *α* (0.05)**	Significant changes are observed and hence Null Hypothesis is rejected
H4	Resilience	Teamwork	**0.7786**	***p* (.0001) ≤ *α* (0.05)**	Significant changes are observed and hence Null Hypothesis is rejected
H5	Resilience	Communication	**0.8471**	***p* (.0027) ≤ *α* (0.05)**	Significant changes are observed and hence Null Hypothesis is rejected
H6	Resilience	Performance Appraisal Process	**0.8764**	***p* (.0000) ≤ *α* (0.05)**	Significant changes are observed and hence Null Hypothesis is rejected
H7	Resilience	Training	**0.8440**	***p* (.6541) > *α* (0.05)**	Significant changes are not observed and hence Null Hypothesis could not be rejected
Overall Resilience			**0.8554**	***p* (.0075) ≤ *α* (0.05)**	Significant changes are observed and hence Null Hypothesis is rejected

The analysis of the Survey data conducted confirmed the effectiveness of the initiatives taken by the company and practiced by the execution team. The teams were able to achieve the objectives even in the trying conditions of the COVID-19 pandemic.

3. Discussions

Organizational change management initiatives are heavily dependent upon not only the system and processes but also upon employee participation and the speed of adopting the change in toto by the employees. No initiative succeeds unless employees

are part of the change management initiative as an important stakeholder. It is not a function of few senior leaders deciding what is right for the organization and assuming that it would set the direction and ensure effective implementation. The study was conducted with the group of employees whose senior managers had discussed, debated, and implemented some changes with the aim of improving the way of working. The survey results indicated the employee perceptions about those changes.

Out of the three aspects viz. Project Planning, Project Execution and Project Review Processes, the employees believed that both Project Planning and Project Review Processes had shown positive changes during the pandemic times but the Overall Project Execution had not shown any significant changes. The WFH situation created a situation where the Managers had to plan and communicate weekly deliverables and necessitated periodic reviews however, it did not improve the Overall Delivery. The study also showed that there was no deterioration in the execution and delivery. At an aggregate level of Risk Management, employee perception showed considerable improvements during the pandemic period.

Resilience in an engineering consulting organisation is the ability of the team to withstand the adverse conditions and bounce back from difficulties/ hurdles that are encountered to sustain and even improve upon the Project Deliveries. As can be seen on the issues of Teamwork, Communication and Performance Evaluation, the perception of employees shows significant changes. There was a widespread apprehension at the beginning of WFH that due to loss of face-to-face interactions, teamwork might deteriorate. However, the efforts made and the resources invested into these areas seem to have helped in making WFH effective. Training on the other hand has not shown such improvement. At an aggregate level of Risk Resilience, employee perception shows considerable improvements during the pandemic period.

4. Conclusion

Adverse conditions especially like COVID-19 rarely occur but such they also provide opportunities to organizations to test and address the gaps in the areas of managing risk and resilience to sustain their business operations. Management and execution teams that address the needs arising out of such adverse conditions make a positive impact on business sustenance and growth. The study was a major effort in quantitatively analysing the impact on employee perceptions about various steps initiated by the management in the areas of risk management and resilience. A more detailed analysis based upon experience level of employees, their gender and project execution in domestic or international market would also be educative.

The effectiveness of risk management and resilience depends heavily upon processes, procedures, keeping pace with developments, deployment of non-human resources and the most important the people. Continuous dip stick surveys could provide the necessary feedbacks to policy and decision makers to enact the policy changes and check the efficacy of the same.

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Risk Assessment & Mitigation of Coastal Erosion in Odisha

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1.0 Background

The problem of coastal erosion has become a national issue in India during the last two decades. It has been further aggravated due to climate change, rising of sea level and global warming. It is therefore necessary to assess the risks of erosion of the coastline and draw up plans to eliminate or mitigate them.

There are several hypotheses regarding the reasons for coastal erosion during the last few years in Odisha (Orissa), a maritime state in the eastern part of India, which is going through a very severe coastal erosion problem. There are several views by researchers, scientists and officials. The present paper attempts to highlight the severely affected areas of Orissa - Puri, Gopalpur, Satabhaya and Pentha stretch of Odisha Coast.

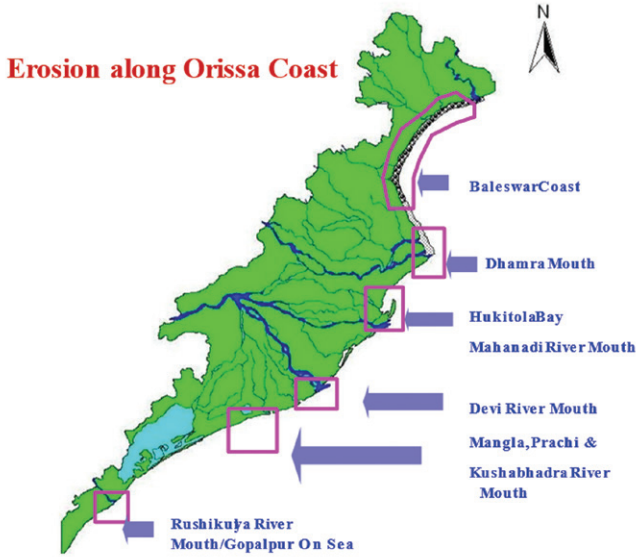

Figure-1: Map showing active erosion sites along Orissa coast

2.0 Erosion Affected Locations

2.1 Puri

Puri (19° 47" N, 85° 50" E), one of the most popular pilgrim towns has wide beaches which are nearly 7 km long. There are two semi-seasonal rivers on either side of Puri. River Mangla about 5km to the south and the River Nuanai about 9 km to the north and both discharge into the Bay of Bengal. The first event of beach erosion was reported during July 2007 in between Puri town and River Mangla. The worst affected segment of about 2 km of Puri's beach was on the southern side of Swarg Dwar/ Lighthouse beach. At that time, erosion was noticed from the water front up to a metal road abutting the beach. The road had been constructed on the sand dunes that had been there. During the monsoon season of 2007, the erosion was upto a distance of 120 m inland. There was almost a 3-meter vertical cut along the beach side of the road (Photo-1).

The unusual erosion pattern along the coast might have been due to the rough sea conditions and high waves throughout the monsoon months of June to September in that year. It is also believed and confirmed by the

Photo-1: Erosion at Puri in between Lighthouse and Sterling Hotel beaches

author that due to the closing of the mouth of River Mangla by a sand bar, the hydraulics behaviour of the water changed and it found other ways to run through the beach to the northern side and that resulted in the erosion of the beach. He also pointed out that the sediment transportation had been disturbed due to accretion at the south side of the new mouth at Chilika. There was thus lesser littoral movement from Chilika towards Puri beach. The state authorities took temporary remedial measures such as packing of sand filled polythene bags on the seaward side of the eroding road. During a visit in September 2017, it was noticed that the erosion of the landward side had not advanced further and in fact accretion was noticed at a few places along that sector of the beach. The observation corroborates with the general seasonal erosion and accretion pattern that prevails during the SW monsoon and also the NE monsoon months respectively. Even though, more accretion is likely to occur, it would be rather a remote chance that accretion would nourish the entire eroded beach sand upto the vertical erosion point - a distance of 200 m from HTL at present. Therefore, remedial measures are necessary to restore the beach conditions. In case of Puri and Konark it was observed that the eroding sites are approximately 2 to 3km north of the mouths of the rivers. It is apprehended that the sand bar formation at the river mouth and northward extension of sandbar during southwest monsoon months which occurs by trapping the northward moving littoral drift might be one of the factors for initiating erosion on the southern beaches. Enquiries revealed that the sand bars and river mouth position were unusual this year (2021). Usually, the local people cut the mouth of River Mangla to create an opening and a free channel to flush out the excess amount of freshwater and sediment. However, in the previous two years (2019 & 2020) the mouth had not been cut open, as a result of which at the height of flooding, the river flowed northward, parallel to the shore for one km and ultimately created a breach at the week point and flowed into the sea. Thus, one of the important long-term solutions is to keep a free connection between the river and sea so that during the SW monsoon the sediment is discharged from the river and gets transported to the northern beaches.

2.1.2 Short-Term (Immediate) Measures

One of the most accepted methods for restoring an eroded beach to the normal conditions is nourishment of the beach by sand, a proven environment friendly method. Puri, being a tourist beach, artificial beach nourishment is the most desirable and recommended method. The sand required for the beach fill could be obtained by dredging some portion from a long sand spit at the nearby mouth of River Mangla and other available riverbeds. As present, the wave direction is predominantly from east and northeast and the long shore transport is towards south. The sand could be brought by trucks and dumped immediately north of the major eroding site.

It is also believed that the alongshore sediment movement has been affected due to accretion of sand in the artificial mouth of the Chilika lake which is 20 kms south of Puri. It is estimated that approximately 15-20 million cubic meters of sand have been deposited and that forms a new beach. As the east coast of Orissa has highest littoral movement from south to north due to the SW monsoon, a suitable and holistic coastal morphological study is essential to understand the coastal processes.

2.1.3 Long-Term Remedies

In order to work out long-term solutions to solve the problem of erosion, tasks relating to collection of data of Oceanographic parameters need to be undertaken. They would include bathymetry survey along with wave climate data to develop a hydrodynamic and sediment movement model to understand and prepare a sediment budget. A detailed littoral regime model also needs to be established with predominant wind-wave and sediment discharge into the sea from rivers.

Photo-2: *At the new Chilika Mouth – Dr Ajit K Pattnaik, former CEO, CDA and Dr Ajay Pradhan, MD of DHI India, February 2002*

Photo-3: *Taken in 2008 shows a two kms long beach formed between 2002-2008 after opening of the mouth of River Chilika at the location shown in Photo-2*

2.2 Satabhaya & Pentha

Pentha (20° 32.5”N; 86° 47.5”E) is an agriculture village in Kendrapara District. It is at a peculiar location, at almost the till the tip of a beachfront from the land where agriculture is being undertaken. The beach is separated by an embankment having a height of approximate 3 meters and a length of about 1.5 km, out of which, the most vulnerable zone is 400 m.

2.2.1 A detailed Analysis of Pentha

A beach morphodynamics survey had been carried out during 2004-06 for the Gahirmatha coastline – Satabhaya village to the River Dhamara mouth, a distance of about 20km. The village is located 18km north of Pentha. The results clearly indicate that the entire coast has been experiencing erosion at the rate of nearly 80m to 100m per annum along certain stretches and the High Tide Line (HTL) is shifting towards the land. A comparative analysis of 1972 toposheets and the recent satellite images indicate that nearly 200 – 300m of the coastline has receded landward, which is also in conformity with the available records and the local villager’s statements. This long-term trend of erosion could be mainly due to the predominance of high wave activity as most of the time the cyclone crosses the coast at this segment, lower quantity of fluvial sand supply from the Mahanadi and tributaries rivers and entrapment or diversion of northerly littoral drift after the construction of Paradip port. The impacts have been felt since the inception and functioning of the Hirakud dam (1956) and the Paradip Port (1964) in the late part of 1960‟s and in successive decades.

As per the reports by the local villagers and the Water Resources Department of the Government of Orissa, that the stretch of the coast adjacent to the Pentha village is under continuous erosion for the last few years. The erosion was severe and the saline embankment was at stake of collapse due to storm surges especially during severe cyclone passing through almost every year since 1999 super cyclone. One of the basic reasons is that during southwest monsoon months, Orissa coast experiences frequent depressions and cyclonic storm within a short span of time. The physiography of the

Photos-4 & 5: Coastal Erosion and Temporary Protection Measures at Pentha

surrounding area of Pentha indicates that the area is located in the northern side of the Hukitola Sandspit and the Bay, north of the mouth the River Mahanadi, indicates that the growth of a long sand spit extending northwards that diverts the sediment offshore, and hence the shore of the Pentha is devoid of the sediment.

2.2.2 Probable Causes of Erosion

The probable causes of erosion at this site might be the physical setting of the coastline, the bathymetry of the adjacent nearshore that affecting the wave climate of the area, the variability in sediment input from the Mahanadi and the alongshore littoral drift which used to previously nourish the beach has been interrupted or diverted due to presence of the Hukitola spit and the orientation of the coastline in a bay form.

2.3 Gopalpur-on-Sea

Gopalpur-on-Sea (19° 16" N and 84° 55" E) is a semi-urban town and a popular tourist recreation site along the south Orissa coast. Immediately north of Gopalpur, a small body of backwater, the Haripur creek joins the sea in a north-easterly direction. It is fed by monsoonal stream and at the peak of the rainy season the fishermen cut open the beach and establish a connection between the creek and the sea for aquaculture purposes. During the northeast monsoon the bar formation closes the mouth and the water body is separated from the Bay of Bengal for the rest of the year. Two semi-perennial rivers, discharge into the bay near Gopalpur, the River Bhauda about 10 km to the south and the River Rushikulya about 23 km to the north. Between mouths of the two rivers, the coastline is completely a sandy stretch with a wide backshore of 100-150 m.

Well-developed sand dunes with continuous ridges running parallel to the shore are conspicuously present along the entire coast. The rear dunes are stable with typical dune vegetation and casuarina plantation. Along the backshore there are scattered secondary dunes of different dimensions and upto 8 to 10m high. The dunes are important sources of heavy mineral concentrates. A rare earth factory of Indian Rare Earths Limited, is functioning 8 km north of Gopalpur near the fishing village of Arjyapalli. An open coast seasonal port was constructed in 1987 by excavating the basin on the backshore near IRE limited and connecting it to the sea through a channel across the beach. Presently, two breakwaters have been constructed for an all-weather port. While the construction of the port is in progress partial operations are on for iron ore and other cargo.

The overall observations by earlier studies explains that the monthly average of the sediment budget on the Gopalpur coast indicates a major loss during the months of April to August, a major portion of the sand, 84% that is lost is restored in October and in the subsequent months, deposition on the beach face results in a net gain of sand by the end of the annual cycle. However,

intermittent erosion during summer monsoon months/ cyclonic events reaches severe dimensions.

The Gopalpur-on-Sea settlement is located nearly 6 m above the Mean Sea Level (MSL). The beaches at the Gopalpur tourist beach are around 600 m long and nearly 50 – 60 m wide and have an inter-tidal region of about 20m experience active erosion during the southwest monsoon period.

During cyclonic events, sometimes, the wave effect is strongly felt and some of the Hotels existing on seafront usually take safety measures by constructing stonewalls as a part of precautionary measures, which is more or less regular activity every year.

Photos: 6 & 7: *Hotels right on the High Tide Line along Gopalpur Coast*

This unusual erosion observed during some years, and they might be attributed due to persistence of localized high waves attributed to continuous weather disturbances and low-pressure system in the Bay of Bengal that has created a sea level surge. This caused scouring of sand from the bottom of the concrete structures of the existing Hotels and causing a void space under the structures and dislocating it, ultimately eroding it. Hopefully, this will be normalized once the waves and weather conditions become normal. As per the recent information, it has been observed that the beaches have started growing up and consolidation of berm has already started.

As per the available records, in the last two decades, the shoreline has remained at the same location without any major erosion towards the landside. From that it can be inferred that the erosion event along the coast is more seasonal and cyclonic dependent and site specific. Therefore, no short-term measures are suggested at present. However, it is proposed to monitor the sand acreation at the north of the south breakwater of the new Gopalpur Port and the erosion activities on the northern side of the port.

2.3.1 Long-Term Measures

The long-term remedial measure could be either beach nourishment, dredging of the river mouths to allow the natural flow of water and sediment, and if required construction of submerged reefs with geo tubes to reduce wave action.

3.0 Meteorological Ocean Data Analysis

3.1 Wind and Wave

Geologically speaking, the level of the sea surface determines the relative position of a region's shoreline. The local climate, through its wind regimes, and the wave set up generated by those regimes at the regional and local scales are of fundamental importance in the understanding of the processes that drive coastal erosion.

Wind blowing over the water surfaces triggers various oceanographic processes at the edge of the ocean.

The wind direction, particularly the long-shore wind initiates near-shore currents and thereby littoral drift. The wind velocity intensifies all its impact, and strong onshore and offshore winds contribute to the sub-aqueous sediment transport through down-welling and up-welling currents.

The other important variable involved for modifying the coast are the waves. The waves change in their characteristics such as wave height, frequency and energy daily, seasonally and spatially. However, it is important to note that the coast responds relatively slowly to the attack of the waves except during period of storm waves. This is one of the crucial parameters that determine the general character of the coast at a particular time. Coasts exposed to waves from a variety of directions, heights and frequencies are much more complex in both plan and profile than those that are affected by lesser variable wave regimes.

The waves that mostly impinge on a shoreline are those that are generated either by local winds or by storms at a relatively great distance from the shoreline. Waves that are generated locally are known as "seas" and waves generated by a distant storm are referred to as "swells". The two types of waves (seas and swells) exist simultaneously at any time in open water. However, the local wind waves or seas obscure the swell, except near shore where the swell peaks up to a greater height. The swell generally contains much more energy than the local wind waves and hence is an important sediment-moving factor when the energy is released by "breaking" at a shoreline. The relationships between the type of wind generating and the characteristics of waves are fairly well established and the wave characteristics (height, period and direction) from known wind conditions can be fairly estimated from empirical relations either using a model or graphical methods.

3.2 Waves near the Coast

When waves approach a coast with crests parallel with the shore, important transformation occur in the wave characteristics. While the period remains the same, the wave velocity and the wavelength decrease but the total energy is slightly reduced by the bottom friction. The height first decreases by a small amount as the waves move into shallow water and then increases up to the point of breaking. A maximum wave height occurs at this point. The breaking action is accompanied by relatively high accelerations and velocities of the water particles, resulting in a highly turbulent condition that is capable of placing large amounts of sediments into suspension.

When these waves break at an angle to the coast, the momentum of the breaking wave generates onshore currents that flow in the direction of propagation of the breaking wave and its bore. The pile up of water along the shore causes longshore currents flow parallel to the beach inside the breaker zone. The water in the longshore current return's seaward as rip currents. The near coast bathymetry plays a significant role in altering the direction and velocity of wave induced currents.

Waves approaching a shoreline at an angle not only undergo the transformations but they also bend or get refracted because the inshore portion of the wave front travels at a lower velocity than does the portion in deeper water. Consequently, the waves swing around and conform to the bottom contours. The characteristics of the bottom topography, the wave period, and the wave direction in deep water, determine the pattern of the wave crests in shallow water. The result of refraction is a change in height and direction of the waves.

The wave climate in Odisha coast is predominantly south, southeast direction during most of the period except the north east monsoon period. The magnitude of these changes can be estimated by the refraction pattern. The convergence zones are the regions of high concentration of wave energy that trigger erosion.

3.3 Tides & Sea Level Variations

Water levels variations in the coastal areas to a prominent level are caused by oceanographic, meteorological, hydrologic, geologic, seismologic and eustatic factors. The first three factors are important for the seasonal variations whereas, the other four are important for long-term variations of seawater level. The coastal

geomorphology is partly affected by variations of these levels. The variations can be short-term or long-term. The short-term regular variations are affected by the semi-diurnal and also associated with phenomena of tsunamis and storm surges.

Sea level due to anticipated global warming is said to be rising currently–at 1 mm - 2 mm per year, though this rate may not necessarily be the same throughout the region. Although, the impact of sea level rise on a regional or local scale may be difficult to differentiate from the contributions of other factors, but the possible effects of sea level rise should be incorporated in the long-term forecasts of shoreline change and for undertaking any shore protective measures.

4.0 Coastal Geomorphology and Processes

4.1 Geomorphology and Beach Morphodynamics

A beach is a dynamic environment when its loose granular sediment continuously responds to the ever-changing waves and currents imposed from the adjoining body of water. The appropriate method of evaluation of this dynamic environment is by determining its profiles. The cycles of beach profiles show that offshore shift of sand from the berm to the bars takes place during storm conditions of large wave activity. Alternately, during smaller swell wave conditions, sand shifts back onshore and the berm grows. The beach profiles developed in the two cases of large storm activity and smaller swell activity are termed as "Storm Profile" and "Swell Profile" respectively. "Summer" and "Winter" profiles usually characterise respectively the depositional and erosional trends of the beaches above the low water level. A beach profile resulting from prolonged attack by uniform waves is referred to as an "equilibrium profile". In addition to long period changes, the beaches also undergo seasonal fluctuations due to the changing wave conditions. The nature of seasonal fluctuations at any place depends on various factors such as the degree of wave exposure, the slope of the foreshore and the type and characteristics of the sediment and the nearshore bathymetry. The seasonal beach changes are magnified due to proximity of a protruding coast, river mouth or obstruction by sand spit on the lee side. Further, short-term beach changes may also occur due to offshore-onshore movement of the beach material especially during and after cyclone periods. Sediment deposition is intimately associated with availability of sediment (source) and longshore sediment transport. The sediments move onshore, offshore and along shore as either bed load or suspended load under the action of waves and currents. Sediment movement perpendicular to shoreline (onshore-offshore) is responsible for short-term coastal changes whereas the along shore movement is important in causing major long-term changes of the coastal zone.

4.2 Longshore Sediment Transport and Coastal Processes

The longshore transport of sediment is caused mainly by the action of waves and currents in the surf zone. The material transported along the shore in the littoral zone by waves and currents is known as the littoral drift. The waves breaking at an angle to a shoreline generates long-shore or littoral currents. It is that current, combined with the agitating action of the breaking waves, that is the primary factor for causing movement of sand along coastline. The movement takes place in two manners in suspension and by rolling in a zig-zag motion along the beach face. As much as 80 per cent of the material moved by wave action is moved in the area shoreward of the breaking point. The direction of littoral drift at a particular time is dictated by the direction of the along-shore component of wave velocity at the breaking point. Along Orissa coast, important reversals in the direction of littoral drift occur because of the seasonal variation of the direction of wave attack. So, it is necessary to know both the direction of littoral transport at any one time and the predominant direction of littoral transport over a normal climatic cycle. The predominant littoral drift in the coast of Odisha is northerly due to the South-West Monsoon from June to September. However, there is also a southerly littoral drift during the North-East Monsoon. It is estimated that there is a net northerly littoral drift or sediment transportation in the coast of Odisha is in the order of 0.8 million cubic meter to 1.2 million cubic meter.

5.0 Possible Mitigation Measures

Coastal protection comes under the State Water Resources Department and that had initiated temporary measure by packing large size sand bags along the sea face side of the embankment for dissipating the wave energy and to protect the embankment near Pentha and Satabhaya. To some extent it has proved to be working. For long term measures, the state government has made a proposal to strengthen the embankment and another supporting parallel embankment or surge embarkment after carrying out the coastal morphology with probable cyclonic effect.

It is proposed to dredge and desilt river mouths especially for the rivers Rushikulya, Mangla, Chilika, Nuanai, Devi, Mahanadi regularly to ensure smooth discharge of flood water during monsoon. That would also ensure the supply of sediment to maintain the beaches and prevent their erosion.

6.0 Climate Change Adaptation

It is believed that erosion would be more and more severe with additional impact due to Global Warming which in turns would result in Sea Level Rise and starvation due to supply of sediment from catchments which will affect coastal areas but more so all the deltaic regions of Orissa. It would be prudent to focus initially on the Mahanadi-Bramhani-Baitarani Complex Delta, both in terms of biophysical and socioecological change over time including delta management and policy evolution. The once prograding delta is experiencing accelerated population growth, decline in income from agriculture or fisheries, increasing pollution in the river system with potential of acidification of estuaries, proliferation of plastics in the environment, degradation of mangroves with loss of biodiversity and human migration. It is therefore, proposed to carry out a holistic study of the entire coast line with field measurement and monitoring with systematic approach in understanding the complex and very dynamic coastal processes.

It is proposed to study all aspects of wave dynamics, cyclones, storm surges and their impacts on coastal processes. It is also necessary to study the catchment area of the entire coast with sediment discharge and runoff from the large rivers into the sea. A detailed regional and coastal 3D model both physical and virtual incorporating all parameters including probable sea level rise and climate changes need to be created to enable proper study, ascertain the vulnerability and suggest remedial measures.

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Risk Mitigation of Structures through Resilient Design

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Introduction

Many materials in nature possess the unique property of elasticity by which they can revert to their original state after removal the load or stress causing the deformation. When applied to a designed system, this similar concept is termed resilience. The property of resilience is defined in common language as the ability of the system to bounce back to its original level of functionality after being subject to a hazard. According to definition by IStructE[1] , *"A resilient built environment is designed to mitigate the effects of hazards. It is also able to adapt to longer-term changes in use or the environment"*.

Thus, a resilient community when faced with hazards should have the following attributes:

a) Design to mitigate identified/ identifiable hazards
b) Adequate preparation against disastrous events
c) Ability to respond to the events
d) Ability to resist the effects of the disaster
e) Recover desired functionality from the effects within specified time in an efficient manner.

The potential hazards are identified through a risk assessment process. This process helps in developing response and recovery plan from the hazard and to adapt to a continuously changing environmental factors.

Resilience in Built Environment

The built environment demonstrates resilience behaviour through mitigation measures to avoid, resist, reduce, and recover from disaster. Short term events include natural disasters like earthquakes, extreme weather events, floods, tsunami, landslides, volcanic eruption or other emergencies like fire, pandemic, major vehicle accidents or explosions. Long term events are the gradual changes in climate and environment and social changes. Structural engineers play a vital role in developing a built environment with resilient and adaptive structures.

Resilience in structures is their ability to quickly resume the designed functionality after the occurrence of the incident. In order to achieve this, the structure should be able to:

a) Avoid, lower or remove identified hazards and threats
b) Prepare for disaster situations
c) Resist the effects of disaster events
d) Recover from the effects of the disaster

The resilient design of a structure involves the following aspects:

a) Identify potential hazards that could disrupt the functions or affect the life safety and the effort required to rehabilitate
b) Designed considering all possible shock events and recovery from them
c) Design for life safety and protection to environment by resistance to disproportionate collapse

d) Reduced need for repairs after shock events and improvement of life-cycle sustainability
e) Design for maintenance and recovery works
f) Recover functions quickly after a short-term extreme event

Risk Management Approach to Resilient Design

The definition of risk according to ISO 31000: 2018 is a product of the likelihood of the occurrence of an event and its consequences, refer Equation 1.

Equation 1
Risk = Likelihood of event * Consequence

In case of natural disasters, the event is a natural hazard like earthquake, cyclone or flood. The consequences include loss of life and losses to assets in financial terms. In case of built assets, the consequence is defined in terms of chances of exposure to event and the vulnerability of the asset and its exposure to natural hazard. The risk equation for built environment is expressed as in Equation 2 and Figure 1 as a combination of the effects of hazards (H), exposures (E), and vulnerability (V) of the assets:

Equation 2
Risk = Likelihood of event * Likelihood of Exposure * Vulnerability of Assets

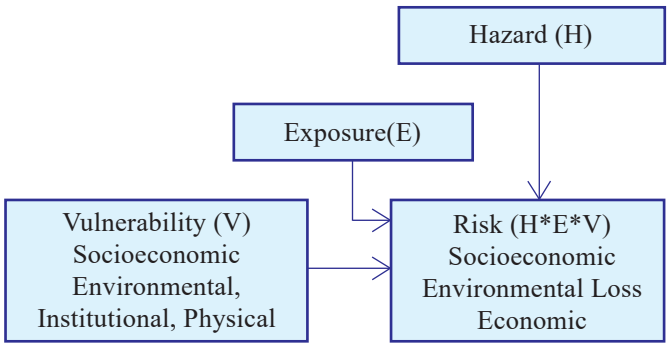

Figure 1:Risk assessment for climate hazards and natural disasters[2]

The vulnerability of a built structure is the loss of integrity, functions, and serviceability under the effect of the hazards, expressed in financial, social or environmental terms. Vulnerability is associated intimately with the capacity of the structure. This inherent property is the ability of the structure to resist effects from hazardous events without losing integrity and functionality.

Resilience through climate adaptation and reduction of disaster risk is implemented through the following means, see Figure 2:

a) Reduction of vulnerability of assets
b) Reduction of exposure of asset to hazards
c) Reduction of residual adverse effects of hazards

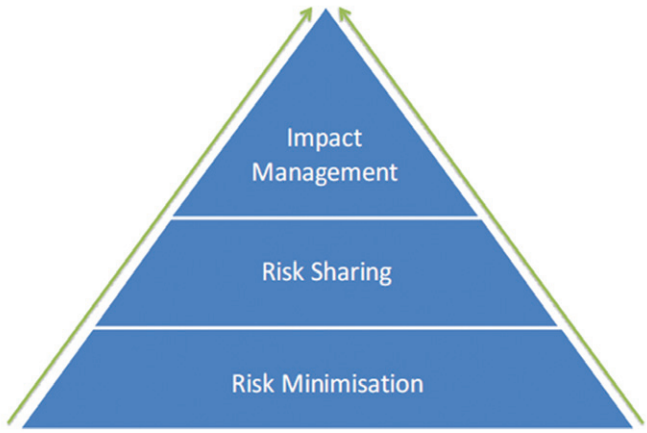

Figure 2:Risk management for disaster resilience2

Strategic approach to lower climate change and disaster risks include:

a) Minimization of climate change effects by reduction of carbon emission
b) Improving green zones to reduce heat effects
c) Change land-use plans to reduce risk of exposure to extreme weather events like avoiding low lying areas
d) Use higher strength materials to improve structural resistance
e) Development of emergency action and relief plans for post disaster management
f) Through regulation and policy frameworks that include national and regional climate change and action plans, disaster reduction and management framework, and specifications and practice guidelines from building planning code and structural design codes, see Figure 3.

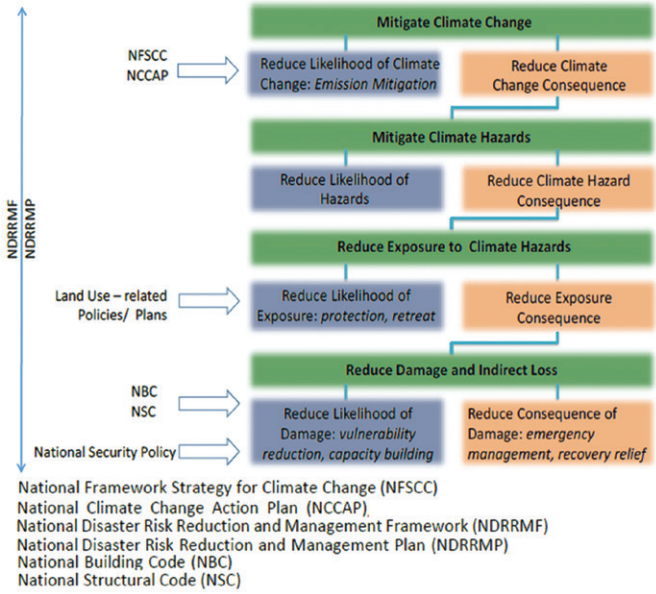

Figure 3:Risk minimisation through policy framework[2]

Though risk and resilience assessment are related, quantification for resilience analysis introduces changes from the risk analysis as shown in Table 1.

Table 1: Comparison of risk and resilience perspectives

	Risk Management	Resilience
Design principles	Preservation of status quo, that is, avoid transformative change; minimize risk of failures	Adaptation to changing conditions without permanent loss of function (e.g., changing paths, if not destinations) Acknowledgment of unknown hazards. Intentional failure may be allowed at subsystem level to reduce the possibility of permanent loss of function in larger system
Design objectives	Minimization of probability of failure, albeit with rare catastrophic consequences and long recovery times	Minimization of consequences of failure, albeit with more frequent failures and rapid recovery times
Design strategies	Armoring, strengthening, oversizing, resistance, redundancy, isolation	Diversity, adaptability, cohesion, flexibility, renewability, regrowth, innovation, transformation[61,62]
Relation to sustainability[63]	Security, longevity	Recovery, renewal, innovation
Mechanisms of coordinating response	Centralized, hierarchical decision structures coordinate efforts according to response plans	Decentralized, autonomous agents respond to local conditions
Modes of analysis	Quantitative (probability-based) and semiquantitative (scenario-based) analysis of identified hazards[64] in context of utility theory (i.e., costs & benefits)	Possible consequence analysis of involving scenarios with unidentified causes

Resilient Structural Design

The methods for evaluating resilience of a structure are[4] :

1. Risk and resistance method of analysis: The design loading and risk of a hazard are assessed based on type of structure, environment, material of construction and location (GIS) of the structure. The resilience of the structure is calculated from the design data. This method is adopted by LEED (Leadership in Energy and Environment Design), "Planning for Resilience" by US Green Building Council and "Building Resilience Tool" proposed by Australian Insurance Association.
2. Hazard specific structural resilience: For a specific hazard (like earthquake or cyclone) the various resistance attributes of a structure are quantified. This method is adopted by rating systems of US Resiliency Council (USRC) using the provisions of ASCE 41, the REDi™ rating system based on FEMA-58 and the Standard for Seismic Resilience Assessment of Buildings of China.

The Pacific Earthquake Engineering Research Centre (PEERC) developed a procedure for performance-based seismic design method. This has been adopted in FEMA-58 (Seismic Performance Assessment of Buildings, Methodology and Implementation) and the Applied Technology Council, US. Using this method and a tool provided, the stakeholders can get information on structural damage, cost and time for repair after an earthquake event. The method for FEMA-58 rating system is shown in Figure 4. The resilience is indicated by the normalized shaded area below the curve of functionality of the structure, shown in Figure 5. This triangle depicts the loss of performance after the event and its recovery gradually with time for a typical disaster like earthquake.

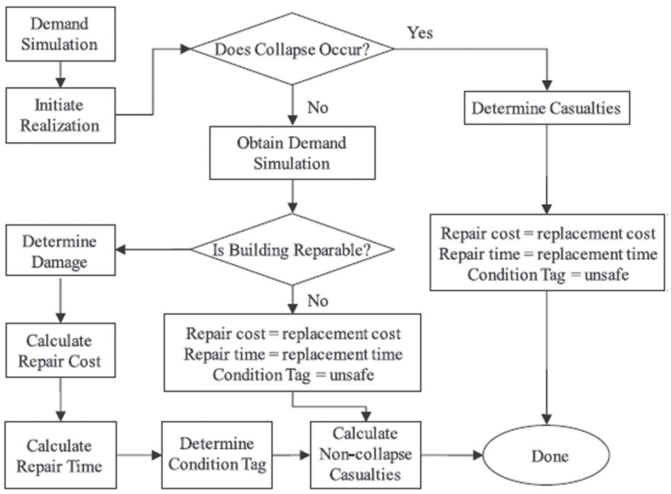

Figure 4:Seismic performance assessment as per FEMA-58[4]

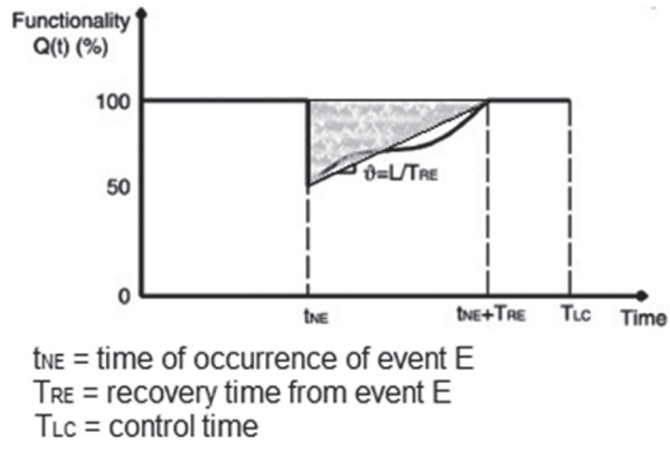

Figure 5:Definition of resilience[4]

Measuring Resilience[5]

The resilience capacity is divided into Absorptive capacity (ability of system to absorb disturbances with little effort and minimum effect), Adaptive capacity (ability of system to modify response to extreme events) and Restorative capacity (ability of system to return to pre-disaster performance and reliability levels). A resilience factor proposed by Royce is based on these resilience capabilities and time for recovery after a disaster; here Fd/ F0 represents the Absorptive capacity and Fr/ F0 represents the Adaptive capacity.

$$\rho_i = \mathrm{Sp}\frac{F_r F_d}{F_0^2},$$

$$\mathrm{Sp} = \begin{cases} \left(\frac{t_\delta}{t_r^*}\right)\exp[-a(t_r - t_r^*)], & \text{for } t_r \geq t_r^*, \\ \left(\frac{t_\delta}{t_r^*}\right), & \text{otherwise.} \end{cases}$$

When tr < tr*

Where,
Sp is the speed recovery factor
F0 denotes performance level of original stable system
Fd is the post-disruption performance level
Fr represents stable performance level after recovery
tr is time required for final recovery
t*r is the time for completion of initial recovery
t_δ denotes slack time allowed after disaster before start of recovery

Approach to Resilient Structure Design[2]

In Limit State Designs, the design load is estimated in terms of hazard severity. This is usually defined by an Average Recurrence Interval (ARI) or Return Period when a hazard event of specific intensity like earthquake of a specified magnitude or wind of a specified speed could be encountered by the structure. A hazard curve which plots the severity of the hazard event and the ARI based on historical event data is used to select a basic design load that would not exceed the probability of occurrence in the design life of the structure. This basic load is modified by a resilience factor to obtain a modified load for resilient design of the structure. This load enhancement would mean additional cost; hence a cost-benefit study is carried out to establish the need for the resilient design.

The cost-benefit study uses the following parameters as shown in Figure 6:

Loss = Increase in cost due to risk mitigation + Loss of opportunity + Other losses

(Loss of opportunity represents lost potential benefit by investing in an area other than resilience of a building, other losses represent potential adverse effects due to resilience design implementation, e.g., impact of flood barrier wall on environment)

Benefit = Avoided loss (value of harm to assets) + Other benefits (continuity of business, productivity, non-displacement of population)

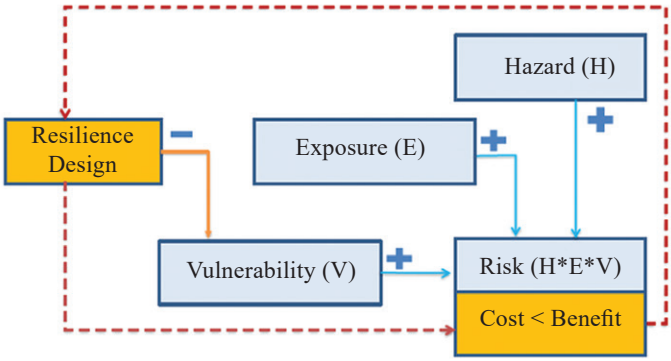

Figure 6:Resilience design options[2]

Resilient Limit State Design[4]

Resilient Limit States differ in concept from the more familiar damage states and associated performance levels prescribed in ASCE/ SEI 31 and ASCE/ SEI 41. These damage states are used to determine strength and deformation demands of structural and non-structural components. Resilience parameters are associated with the ability of the structure to recover to acceptable functional performance levels in specified time. The metrics of resilience include cost of repair, time to repair, casualties and state of operability. For a structure subjected to an earthquake event, the resilience ratings would determine the time required for residents to resume normal operations. This concept is thus an extension of the Performance Assessment methods.

The targets for resilience performance of buildings are defined in Table 2.

Table 2: Seismic performance measures for buildings[4]

Category A	Safe and operational. This describes the performance now expected of new essential facilities such as hospitals and emergency operations centres. Buildings will experience only very minor damage and have energy, water, wastewater, and telecommunications systems to backup any disruption to the normal utility services.
Category B	Safe and usable during repair. This describes the performance needed for buildings that will be used to shelter in place and for some emergency operations. Buildings will experience damage and disruption to their utility services, but no significant damage to the structural system. They may be occupied without restriction and are expected to receive a green tag 1 after the "expected" earthquake.
Category C	Safe and usable after repair. This describes the current expectation for new, non-essential buildings. Buildings may experience significant structural damage that will require repairs prior to resuming unrestricted occupancy and therefore are expected to receive a yellow tag 2 after the "expected" earthquake. Time required for repair will likely vary from four months to three years or more.
Category D	Safe but not repairable. This level of performance represents the low end of acceptability for new, non-essential buildings, and is often used as a performance goal for existing buildings undergoing rehabilitation. Buildings may experience extensive structural damage and may be near collapse. Even if repair is technically feasible, it might not be financially justifiable. Many buildings performing at this level are expected to receive a red tag 3 after the "expected" earthquake.
Category E	Unsafe: partial or complete collapse. Damage that will likely lead to significant casualties in the event of an "expected" earthquake. These are the "killer" buildings that need to be addressed most urgently by new mitigation policies.

The building resilience limit states for Design Level Earthquake obtained from component limits defined in FEMA-58 are given in Table 3.

Table 3: Resilience objectives for design level earthquake[4]

Platinum	Downtime: Immediate re-occupancy (Green tag expected) and functional recovery < 72 h Direct financial loss: Scenario expected loss < 2.5% Occupant safety: Physical injury due to failure of building components unlikely
Gold	Downtime: Immediate re-occupancy (Green tag expected) and functional recovery < 1 month Direct financial loss: Scenario expected loss < 5% Occupant safety: Physical injury due to failure of building components unlikely
Silver	Downtime: *Re*-occupancy < 6 months (Yellow tag possible) and Functional recovery < 6 months Direct financial loss: Scenario expected loss < 10% Occupant safety: Physical injury may occur from falling components (but not structural collapse), fatalities are unlikely

Conclusions

Buildings and structures are very important assets with great commercial and social value. Hazard incidents that undermine their usefulness impact not only the physical facility but also its further usefulness to the society. The traditional risk-based design is a process where structures are designed to be robust against probabilistic disaster intensities. Resilience analysis improves upon this concept allowing the structure or system to better respond to undetermined hazard intensities and evaluate the capacity of the structure to recover functionality after the event. Seismic resilience has been widely studied and documented and procedures are in place to carry out the work. New technologies for quantitative measurement and coupling with a physical mechanism of disaster management would improve the effectiveness of this concept. Resilience of non-structural elements is also critically important for recovery of the building functions and quantification for these elements should be focussed on. Analysis of resilient limit states is done through quantitative models in transparent, documented manner. This approach has gained momentum in the US where various bodies like National Institute of Standards and Technology (NIST), National Fire Research Laboratory (NFRL), Federal Emergency Management Agency (FEMA), American Society of Civil Engineers (ASCE), U.S. General Services Administration (GSA) and the Department of Defence (DOD) are actively developing processes and tools for these studies.

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Risk and Resilience in Structures – Concept Overview and Code Approach Towards Seismic Resiliency

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Introduction

"Risk" is a phenomenon which is very closely embedded in every sphere of the ecosystem. Be it knowingly or unknowingly, one deals with risk at each instant. Most of a person's decision making process always bears some amount of risk. In fact, every decision is taken based on the outcome of risks associated with the event. "Risk" is more commonly perceived as threat. The global community was apprehensive regarding the risk of a pandemic when the outbreak of Covid19 occured in late 2019. It ultimately proved to be true. Hence, "Risk" is a manifestation of uncertainty that arises due to any happening or event. Apart from the pandemic the world is currently facing major risks on account of Climate Change, Economic instability, Geopolitics and Terrorism. Risk can be controlled or mitigated by an efficient Risk Management System but maynot be avoidable in totality.

The talk of "Risk", automatically raises the question in one's mind as to how to counter it, how to regain/ restore the original situation once the disruptions are over. The answer to all these questions lead to one to consider "Resilience". "Resilience" is a phenomenon which enables the systems to sustain during the events/ hazards, absorb the harmful effects and return to the pre-event condition after the disruptions. In somecases "Reslience" is inherently built in and in some it needs to be built into the system. It is obvious that to build resiliency, it is imperative to assess the risks arising due to the events/ hazards and decide the ways and means to mitigate them.

Buildings, Infrastructures and all other structures in Civil Engineering are a major part of the larger environment and are succeptible to risk with respect to various parameters. The most important part is the Safety from the view point of all stakeholders. Safety in turn depends on various factors like design, construction, climate, life of the structure, material, quality, etc. As the number of parameters go on increasing the factors contributing to Safety multiply making the process of risk management and resiliency a complex task. It becomes more critical when the capital cost of the structure also goes higher. There are thorough studies and discussions, particularly in the USA on how to determine Risk and Resiliency in designing of the Civil Engineering structures keeping economic considerations in mind.

The present article gives an overview of "Risk" and "Resilience" in the Civil Engineering structures and how they are built into the Standards and Codes for consideration during the design stage in the context of seismic hazard.

Risk and Resilience in Civil Engineering Structures

Risks

Risk is expressed in terms of the probability of occurrence of a hazard/ undesirable event and the consequences that arise out of those. Mathematically Risk is the product of the "probability of occurrence X consequences". Consequences are the possible outcomes that may happen due to the undesired events (hazards) and may be defined in terms of injuries, loss of life, damage to properties, collapse of structures, environmental damage, economic loss, etc. The hazards may be natural calamity like earthquakes, flood, forest fire, cyclonic storms, etc. A systematic procedure to describe and/ or calculate consequence is called Consequence Analysis[1]. Risk Management for Civil Engineering structures is a very elaborate procedure which broadly constitutes Risk Assessment and Risk Control. Risk Communication also plays a vital role in Risk Management. Risk Communication is the sharing of informations at various stages starting from hazard identification/ estmation, consequences, risk analysis to risk assessment with the stakeholders and getting the feedback in order to formulate a Risk Management methodology. A framework for Risk Assessment is shown in Figure 1.

A civil engineering structure is designed to satisfy the following criteria:

1) Safety to prevent the structure from collapse
2) Functionality for which the building/ structure is intended
3) Durability with the intent to serve the function during its life without undergoing any appreciable distress
4) Compliance to statutory rules, Code and Standards
5) Cost
6) Economics

Each of the above criteria independtly or jointly have some amount of uncertainties or risks and as a result there can be consequences, which broadly include:

i. Injuries, loss of life, loss of properties due to collapse of the structure
ii. Cost of Reconstruction/ Rehabilitation
iii. Financial loss due to stoppage of intended services
iv. Environmental impact
v. Regulatory and Governmental proceedings
vi. Loss of reputation, Brand

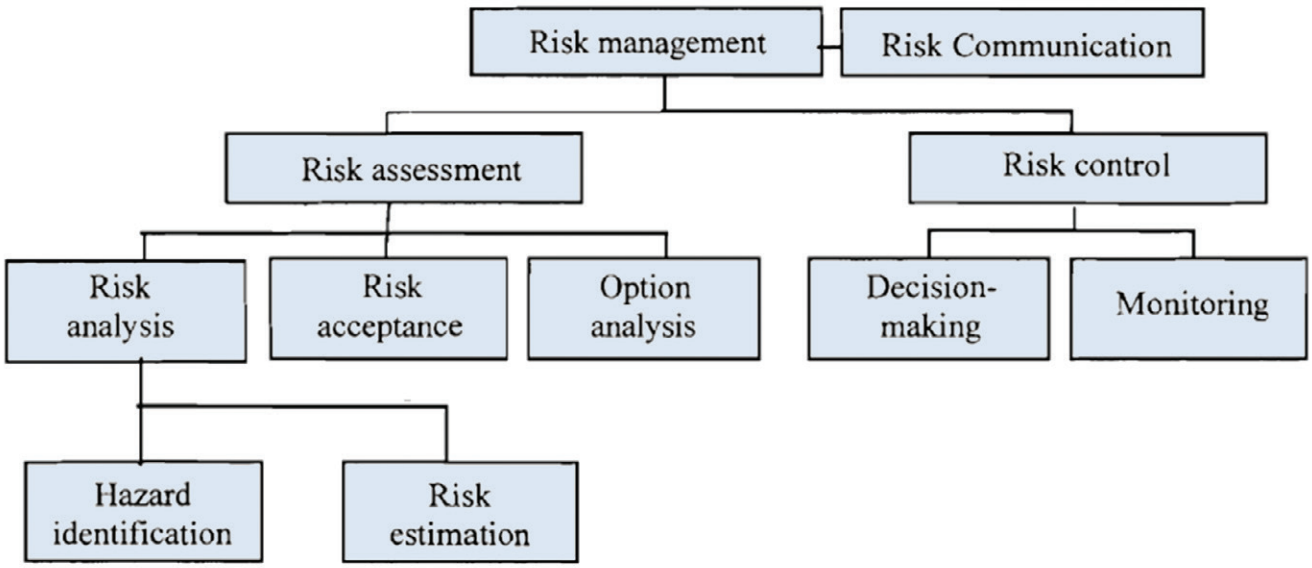

Figure 1[1]: Schematic presentation of Risk Management Framework

Some of the consequences are explicit and quantifiable whereas the rests are qualitative. In order to have a scientific approach it is necessary to do an explicit risk analysis resulting in a target level of performance and to verify the design of the structure with regard to the set target. However, the target level of performance is related to "maximum level of acceptance of risk" which in turn raises the question how to decide that. The CIB Report[1] explains very lucidly the dynamcs of perception of risk or threat by the society. It has been shown that while a building collapse causing some casualties draws considerable attention but road accidents over a year causing more deaths attract almost no attention and media publicity. People are much more sensitive to an event of a very less probability of occurrence compared to an event of high probability of occurrence having worser consequences. Perhaps, the reason is attributable to the attitude of the public who are used to seeing road accidents day in and day out but are not used to see frequent building collapses.

Resilience

The definition of Resiliency may be different depending on the situatons. The term 'resilience' has a number of definitions. For responding to hazard events, it has been defined as "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events" (NAC 2012) or, similarly, "the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions" (PPD-21 2013)[2]. For Civil Engineering, Resiliency may be defined as a phenomenon by which the structure is made to respond to the actions (for example hazards) in a way to sustain and absorb the effects of the actions, recover and adapt itself to the adverse situations. The important factor is that the structures of vital interest like Hospital, Communication Towers, Power Plants, Water Supply System, Roads and Bridges should not be unserviceable during and after a climatic disaster. To fulfill this objective, the concept of building Resiliency in to the structural system is important. This implies on the need to think beyond the way that structural design was performed earlier using the Working Stress Method. There was a need to introduce new methodologies basd on knowledge gained over the years. Safety, however, does not mean that there will be absolutely no changes in the condition of the structural health of a structure following a hazard. What is intended is that it should not collapse so that the occupants, other users, the properties adjacent to the structures/ buildings remain safe and so do the people in them. The concept of resiliency of a structure comes in this context. A resilient structure should respond by undergoing deformation to the extent that the major load bearing elements of the structure are not damaged beyond an accetable limit and thus total collapse is prevented. The structure should be capable of being restored back to the original health to the possible extent within a reasonable time. Codes and Standards have been revised to address the requirements of Resiliency. While the new structures are designed to be resilient, the built structures require to be reviewed

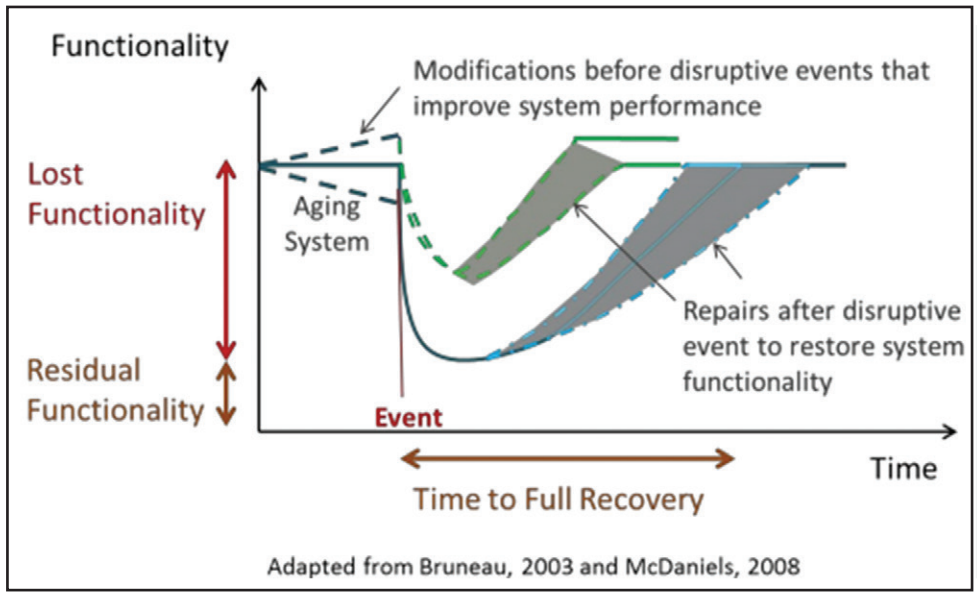

Figure 2[2]: Resilience concept of functionality versus recovery time for theperformance of the built environment during a disruptive event

in order to examine the performance level. The National Institute of Science and Technology (NIST), USA conducted two workshops in 2011 in order to identify the critical gaps and needs in tools and metrics for assessing the resilience of the built environment[2]. Leaders of engineering practice, research communities and standards development communities were invited and the deliberations included the following topics:

a. Need for resilience in buildings and infrastructure systems,
b. Community planning for resilience,
c. Insurance perspective on building and infrastructure resilience,
d. Standards for building, electric power, transportation, and water and wastewater systems.

The resilience concept has been schematically represented in Figure 2. An existing structure loses functionality to some extent due to ageing and loses functionality considerably after a disruptive event.

The figure above indicates that modifications performed in an existing building to impart resiliency improves the performance by reduction of loss of functionality and regaining the original functionality within a shorter period.

Codes and Standards

Most of the Codes and Standards adopt prescriptive requirements which assme that compliance to the various stipulations would make the structure to perform to a desired level . The approach takes care of primarily safety but falls short of addressing the functionality of building and infrastructure systems.

Risks in Civil engineering design mainly pertain to load and materials due to uncertaininties of magnitudes, probabilities of different loads acting simultanoeusly, variability in material behaviour (more predominant in concrete) at different stress levels. In view of this, there has been considerable evolution in the design analyses and methods in the Codal recommendations right from the era of Working Stress Design (WSM) to the current Limit State method (LSM) of design. The risks in design of structures were thought to be more appropriately addressed in case it could be modelled mathematically and as such the theory of Reliability based method of design propagated during mid 1960 and onwards[3]. The risk involved in the design was quantified in terms of a probability of failure. However, the method was unable to draw the interest of practising engineers as it appeared to be complicated. The probabilities of failure or risks and uncertainties were adopted in a simplistic and deterministic manner by introducing Partial Safety Factors for load and materials in the LSM design. All codes try to rationalise the risk by adoptiing different load factors corresponding to various load combinations. An example is given below:

Table 1: Load Factors for Seismic Load combination

IS 1893: Part1	EN 1990	ASCE 7-16
1.2 D+ 1.2 L+ 1.2 SL	1.0 D + (0.3 to 0.8) # L+ 1.0 SL	1.2 D + 1.0 L+ 1.0 SL
D – dead load, L – live load, SL – Seismic load # Factor depends on category of buildings		

Codes recommend basically four factors for seismic resiliency in structures:

i) Introduction of ductility
ii) Capacity design – Strong column weak beam
iii) Limiting the interstorey drift, and
iv) Proper joint detailing.

Ductility

The lateral stiffness of a building controls the lateral displacement during an earthquake. If the structure is made very stifff it will withstand higher force with less displacement within elastic range and will undergo sudden brittle failure in case of concrete. But, instead if the building is allowed to be flexible such that it dissipates the energy by undergoing deformation limited to a certain extent and does not allow the load to be developed to higher level, then the building becomes resilient. This mechanism is termed as ductility which is explained in Figure 3.

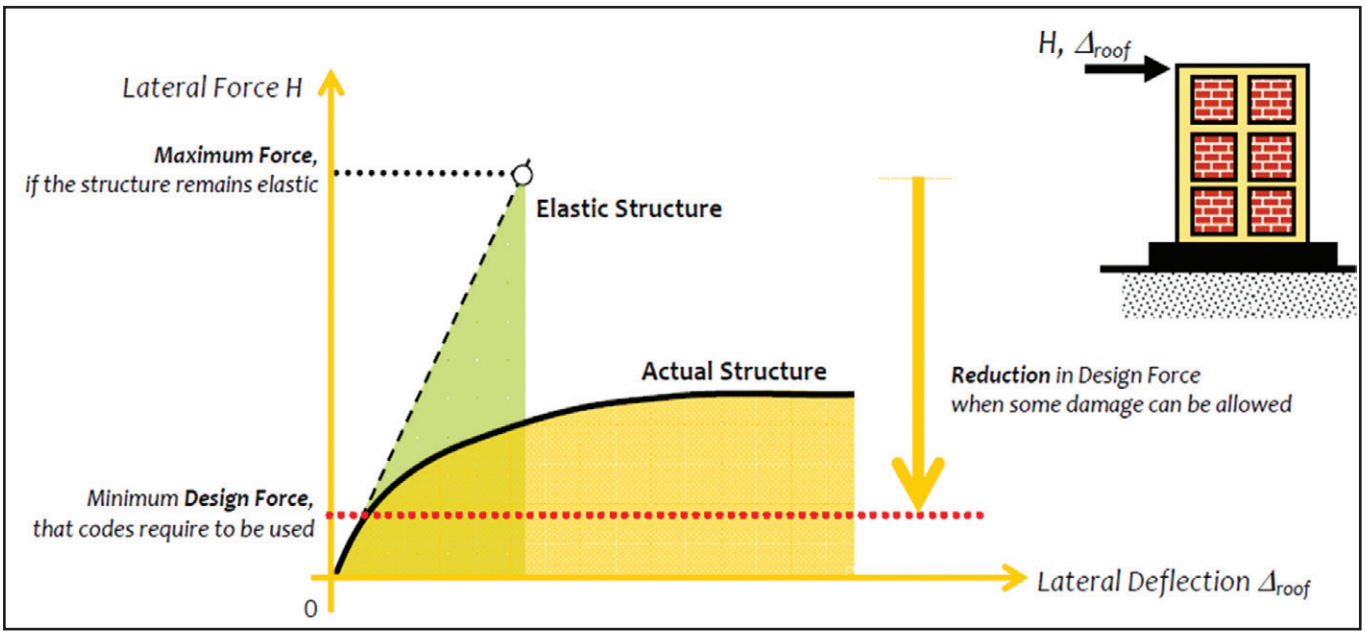

Figure 3[4] : Basic strategy of earthquake design: Calculate maximum elastic forces and reduce by a factor to obtain design forces

It should be ensured that the structural elements and the structure as a whole should have adequated ductility to behave as intended. Ductility induces lesser seismic demand, imparts resiliency and optimizes cost. Good ductility induces acceptable level of damage in the structural elements to undergo larger deformation while retaining enough stiffness to maintain the desired functionality, refer Figure 4.

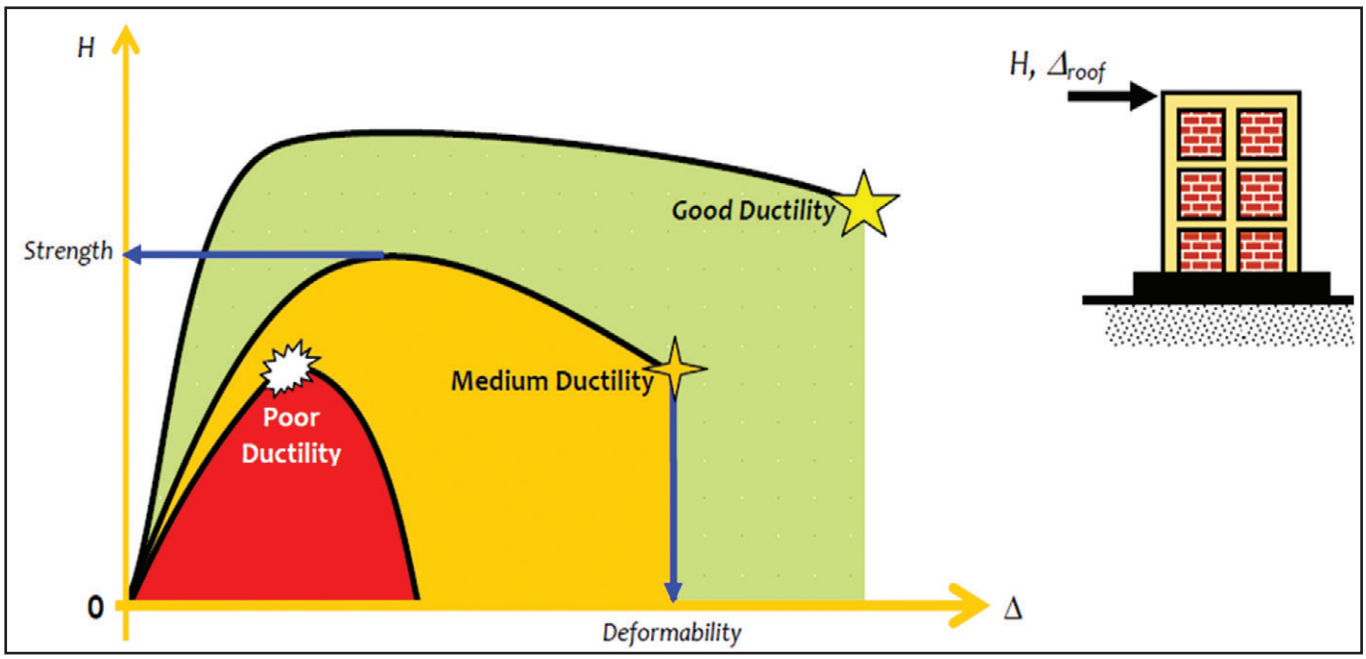

Figure 4[4] : Explanation of ductility levels

Codes recommend a factor depending upon the adoption of structural configurtion and detailing. This factor is termed the Response Reduction factor "R" in Indian code, Behavior factor "q" in Euro code, and Response modification factor in US code.

Capacity Design

The Capacity design concept primarily aims to proceed in a sequence to follow hierarchical capacity requirements of various structural elements in order to achieve inelastic hinges at pre-determined locations. The failure modes which appear to occur prior to desired modes should be systematically delayed. For example, to achieve resiliency, the foundation is of prime importance to remain safe during a seismic event. Thereafter the order would be columns, beams and slabs. Further, for concrete structures, the hierarchical order in terms of superior ductility needs to be ensured for the members in the order of flexure (under-reinforced), shear and axial compression. Therefore, it is essential that axial compression or shear modes of failure do not precede the flexural mode and inelastic hinges are formed due to flexural mode only. This can be easily understood by the Ductile Chain analogy. Suppose, a chain is subjected to a pull as shown in Figure 5., the chain would fail at a certain load and the failure would take place at the weakest link. However, if the weakest link is made ductile, it would result in greater elongation of the chain and other links (brittle) would not fail. On the other hand, if any other brittle link is made weakest, then that would fail suddenly.

Taking cue from the above, the Codes introduced the concept of strong column and weak beam theory which stipulates compliance to the condition given in Table 2 at the beam-column joint.

Table 2: Capacity design at Beam Column Joint

$\sum M_C \geq k \sum M_B$	k = 1.4 IS 13920: 2016 k = 1.3 EN 1998-1-2004
M_C= Moment capacity of Colum at the Joint M_B=Moment capacity of Beam at the Joint	k = 1.2 ACI 318-19

Inter-storey drift

Inter-storey drift is the relative displacement of upper storey with respect to immediate lower storey. Though it is not a structural methodology, but it has importance from the viewpoint of resiliency that it affects the performance of the cladding and walls in a building particularly those made of brittle material. For a resilient structure, it is necessary to maintain the functions during the hazard event and thus Codes specify limits on Inter-storey drift under seismic forces. BIS, Euro and ASCE 7-16 specify various permissible values based on the type of cladding material and importance of buildings.

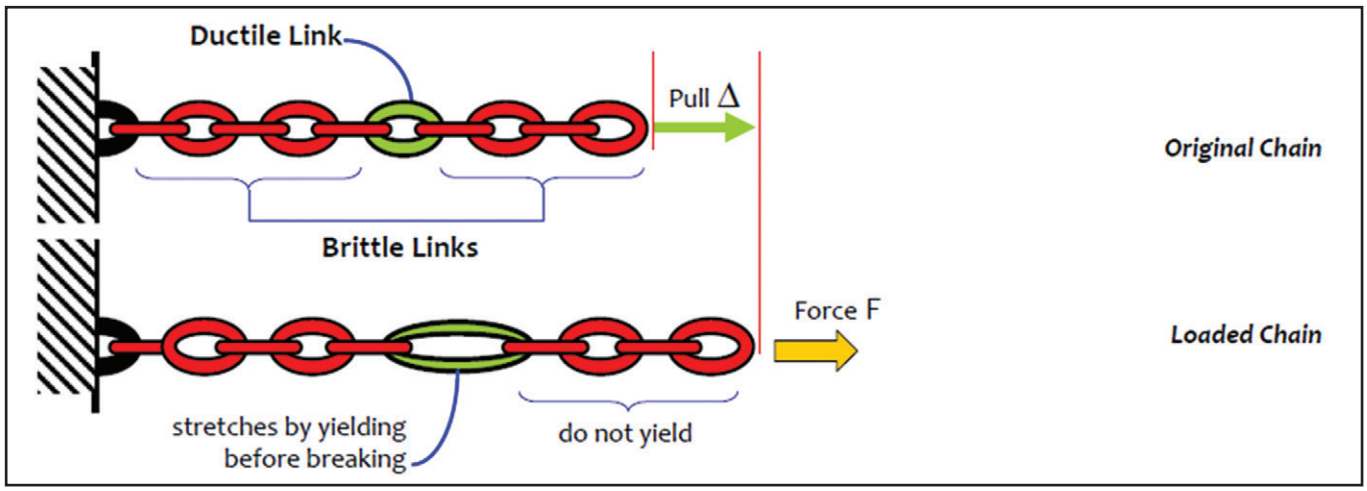

Figure 5[4] : Ductile chain

Joint detailing

Proper detailing is important to ensure intended ductile behavior at the joint locations. All the codes adopt and recommend various stipulations in respect of joint detailing. The stipulations are based on the following requirements:

i. Use of preferably lower grade of steel and providing low tensile steel ratio.

ii. Use of adequate closely spaced properly anchored stirrups to ensure that shear failure does not precede flexural failure.

iii. Confinement of compression steel by closely spaced properly anchored links or spirals to ensure that brittle failure does not take place more so in columns.

Conclusions

All events have uncertainties and bear some risk associated with them. Risk is a probabilistic phenomenon and mathematically defined as product of probability of occurrence of the event and cosequences due to the event. Risks cannot be avoided but can be managed to a certain acceptable level. Risk Management helps to identify events/ hazards, risk estimation, risk assessment, risk analysis, risk control and risk communication. Resiliency is the method of absorbing the risk bearing events without failure and regain the original functionalitiies within reasonable time. Structures and Buildings are subjected to a number of hazards due to climatic actions, earthquakes, blasts, etc. Response of structures against seismic loading has been thoroughly studied and experimented following severe earthquakes across the globe. Codes and Standards have been periodically updated and Indian Code in line with Euro and American Code has adopted measures for seismic resilient structures.

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Future of Hydro-Power Development in Himalayas post Chamoli Flood Disaster

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1. Introduction

The Himalayan region is attractive for hydro-power generation because all the rivers in that, i.e. in Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh originate in the Himalayas and descend from around 3,500 m to 500 m in a short stretch of 200 km. This water wealth and terrain head are nature's gift and a bounty for the relatively underdeveloped north and north eastern states and for the country as a whole (Mazumder,2010).

India has planned a large number of hydro-power projects in the north and north-east where hydro-power potential is in abundance (Mazumder, 2017). Abstraction of fresh water by blocking/diverting flow of rivers for power generation is carried out only after a thorough geotechnical and seismic investigations of the terrain. Public requirements, terrestrial needs, forests, animals and aquatic ecosystem are duly considered. Apart from hydro-power, the project proponents offer drinking water, recreation, tourism, infrastructures, communication, education, employment opportunities of people living in the hilly areas of India.

Execution of the hydro projects is becoming increasingly difficult because of high risks, many unforeseen problems and above all environmental considerations. The recent flood disaster in the Chamoli Valley in the state of Uttarakhand resulted in loss of life, damage to hydropower works and other properties has further strengthened the environment lobby opposing hydro-power projects in the Himalayas. After the flood disaster in the Kedarnath Valley in 2013, The Supreme Court of India appointed a high power committee to report on the matter. Going through the report, the Supreme Court observed (SANDRP, 2020)

"We have gone through the Report and, prima facie, we are of the view that the AHEC Report has not made any in-depth study on the cumulative impact of all project components like construction of dam, tunnels, blasting, power-house, Muck disposal, mining, deforestation etc. by the various projects in question and its consequences on Alaknanda as well as Bhagirathi river basins so also on Ganga which is a pristine river".

Thus, the AHEC Report does not serve as a reference for the disaster incidence. One of the objectives of this paper is to highlight some of these issues and the remedial measures for early completion of hydro-power projects in the country.

2. Hydro-Power Potential Of India

The hydro-power potential of India (vis-à-vis other countries) has been estimated as 90,000 MW at 60% load factor (Table-1) equivalent to about 1,50,000 MW installed capacity. Total hydro-power potential of India (including pump storage, tidal, river linking, mini and micro hydel schemes) is about 3,00,000 MW (Mishra, 2013). 60% of India's hydro-power potential lies in Himachal, Uttarakhand and Arunachal states. Table-2 shows the installed capacity of different river basins in India (Madan,2013).

Table-1 Hydro power Potential in some of the Countries in the World

Countries	Canada	USA	Russia	Brazil	Japan	France	Norway	China	India
Hydro Power Potential at 60% Load Factor (10^3 MW)	341	319	160	286	85	78	122	204	90
Hydro Energy (10^6 KW-hr)	67	80	44	58	28	78	78	65	23

Out of a total of 2,23,626 MW Installed capacity (including thermal, hydro, nuclear, solar and wind), the current share of hydro-power is 37,917 MW i.e. 17 % only against an ideal share of about 40%. Out of 1,48,701 MW of installed capacity, 94, 900 MW i.e. 65.3% is yet to be developed in the country (Table-3).

Table-2 Hydro-Power potential in different River Basins in India

River Basins	Installed Capacity (MW)
Indus Basin	33,832
Ganga Basin	20,711
Central Indian River system	4,152
Western Flowing Rivers of southern India	9,430
Eastern Flowing Rivers of southern India	14,511
Brahmaputra Basin	66,065
Total	**1,48,701**

3.0 State Wise Hydro-Power Development in the Himalayas

State wise distribution of hydro-power capacity in North and North East region of Himalayas is given in table-3

Table-3 Hydropower Not Yet Developed in the North and North East Regions in The Himalayas (as on 2014)

Region/State	Identified Capacity (Northern Region)		Capacity Under Operation		Capacity Under Construction		Capacity in Operation + Construction		Capacity yet to be developed	
	Total (MW)	Above 25 MW(MW)	(MW)	%	(MW)	(%)	(MW)	(%)	(MW)	%
NORTHERN										
Jammu & Kashmir	14,146	13,543	31,19.0	23.03	1,180.0	8.71	4,299.0	31.74	9,244.0	68.26
Himachal Pradesh	18,820	18,540	9,308.0	50.20	2,216.0	11.95	11,524.0	62.16	7,016.0	37.84
Punjab	971	971	1,206.3	100	206.0	21.22	1,412.3	100.00	0.0	0.00
Haryana	64	64	0.0	0	0.0	0.00	0.0	0.00	0.0	0.00
Rajasthan	496	483	411.0	85.09	0.0	0.00	411.0	100.00	0.0	0.00
Uttarakhand	18,175	17,998	3,756.4	20.87	1,430.0	7.95	5,186.4	28.82	12,811.7	71.18
Uttar Pradesh	723	664	501.6	75.54	0.0	0.00	501.6	75.54	39.0	5.87
Sub Total (NR)	53,395	52,263	18,302.3	35.02	5,032.0	9.63	23,334.3	44.65	28,928.8	55.35
NORTH EAST										
Meghalaya	2,394	2,298	282.0	12.27	40.0	1.74	322.0	14.01	1,976.0	85.99
Tripura	15	0	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Manipur	1,784	1,761	105.0	5.96	0.0	0.00	105.0	5.96	1,656.0	94.04
Assam	680	650	375.0	57.69	0.0	0.00	375.0	57.69	275.0	42.31
Nagaland	1,574	1,452	75.0	5.17	0.0	0.00	75.0	5.17	1,377.0	94.83
Arunachal Pradesh	50,328	50,064	405.0	0.81	2,854.0	5.70	3,259.0	6.51	46,805.0	93.49
Mizoram	2,196	2,131	0.0	0.00	60.0	2.82	60.0	2.82	2,071.0	97.18
Sub Total (NER)	58,971	58,356	1,242.0	2.13	2,954.0	5.06	4,196.0	7.19	54,160.0	92.81

4.0. Environmental and social issues and risks in hydro projects

Execution of hydro-electric projects in India is becoming increasingly difficult mainly due to objections raised by several groups of environmental lobby. There is stiff opposition from that group citing several consequences e.g. submergence of land, rehabilitation of affected people, loss of fish and other aquatic life, loss of natural eco-systems, drying of river, silting of reservoirs, etc. There are also risks of failure of hydro power projects due to landslides triggered by earthquake, avalanches, glacial movement/ melting, floods , geological surprises, tunnel construction, etc.

4.1 Run-Off The River/ Remote Type Development

Storage type (Local) development e.g. Bhakra, Tehri, Teesta, etc. is almost impossible to build now a days because of resistance from people dependent on land and forests. Run-off the river type (Remote) developments with limited storage is now a days popular since it creates little storage as the flow is diverted through tunnels to utilize the terrain head for hydro-power generation. A typical diversion type development in river Beas illustrating Barrage, Head Race Tunnel (HRT) and Adits, Penstock, Surge shaft, Power house is shown in Figure-1 (HPPCL, 2011).

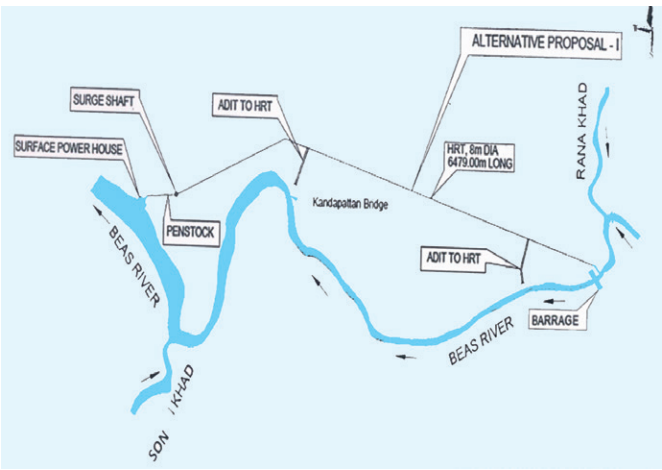

Figure-1 Typical Run-Off the River Hydel Project in Beas River

4.2 Minimum Environmental Flow/ Flushing Sediments

Developers of hydro-power have a tendency to use as much water as possible for generation of power for commercial uses even during the non-monsoon season. However, that should be regulated so that the water needed for periodic flushing out sediments deposited in the pond is not diverted for power generation. Minimum environmental flow should be ensured for aquatic life and river health.

A major problem being faced is the fast depletion of storage capacity due to siltation of reservoirs. Many of the reservoirs built in fifties and sixties are going to be obsolete (Koomullil et.al, 2016, Mazumder, 2016) as their dead storage capacities are full of sediments and their useful life is limited resulting in fast depletion of their live storage space. Sediment deposition and distribution of sediments within the reservoir space is dependent on terrain condition, shape of reservoir, inflow of sediments and other factors (CBIP,1980).

4.3 Problems/ Risks in Tunnelling

In all remote type installations, long tunnels (Figure-1) have to be excavated through the side hills connecting the power house with the power intake. Length of such tunnels is governed by the terrain head to be utilized for hydro-power generation. Construction of the head race and tail race tunnels by blasting techniques cause not only disturbances to the people living nearby, it may actuate landslides too. The problem can be overcome by introducing tunnel boring machines. Tunnelling speed can also be substantially increased by introducing such boring machines. Robotic tunnelling and mucking machines need to be developed to minimise the number of personnel having to work inside and thus the risk to personnel working in the tunnel.

4.3 Problems of Water Supply

Lined tunnels interfere with ground water flow often resulting in drying up of springs and lowering of ground water table. Local people dependent on ground water supply often complain about non-availability of ground water for drinking and other domestic purposes. To

overcome this problem, water can be supplied by gravity from ponds at higher elevation albeit at extra cost to the developers. However, maintenance and overhead costs can be borne by local people if they are assured of firm piped water supply. Prior to hydro-power development, local people used to walk daily down and up the slope for fetching stream water from the valley, which is an arduous task often causing lungs and other respiratory diseases.

4.4 Risk of Land Slides/ Muck Disposal

Hydro-power projects are located in mountainous and hilly regions where the terrain is steep. Often there is landslides due to earthquakes, heavy rainfall/ cloudburst with resultant run-off and avalanches. Thorough geological/ hydrological study of such slide prone areas are now-a-days compulsorily carried out for deciding location of barrage, tunnels, surge tanks, power house, residential areas and to avoid geological surprises. Use of software like Geo-slope is a very efficient tool for finding stability of hill slopes. Slides can be prevented/ arrested by rock bolting, geo-textile netting and construction of gabion walls, etc. The design life of these would be around a 100 years hence regular maintenance is also essential.

The muck generated from tunnelling and other construction works is also to be carefully placed at selected sites with terracing and properly designed retaining walls. A minimum of 50m distance should be kept in between the flood line and first retaining wall so that the muck does not join the river during rainy season.

4.5 Loss of Aquatic Life

All the hydro-power projects are responsible for loss in aquatic life like fishes and others mainly due to drying of the river in the stretch between the barrage and the power house during lean flow season. It is for this reason that the Government of India has enacted the requirement to compulsorily ensure a minimum environmental flow which is usually 20 to 30 percent of the lean season flow. It is very important to monitor that the minimum dry weather flow is admitted to the river from the reservoir either by regulating sluices or by installing dam toe type power house making use of the environmental flow for hydro-power generation.

4.6 Loss of Eco-Systems

Environmentalists have serious objection to building hydro-power projects citing loss of eco-system, destruction of animal and plant life, especially those of endangered species. Their views should be respected and all necessary measures must be adopted to protect the eco-systems. Fish passes of improved design need to be inbuilt. Minimum dry weather flow ensures aquatic life and natural scenario of a river to attract tourists and pilgrims. The birds and animal sanctuaries are also to be protected. An Environmental Impact study must be carried out. It is important to delineate endangered species and their protection measures. For every tree cut, new plants are to be sown. Several benefits have to be explained/ publicised amongst local people by convening get-togethers. Education of all stakeholders is extremely important for the project to yield its full intended benefits, otherwise developers have to face a lot of resistance from local people often misguided by persons opposed to hydro power, especially those with vested interests.

4.7 High Capital Costs

Hydro-Power development needs high capital costs because of long gestation period in acquiring land, rehabilitating affected persons and so on. Developers are required to build roads for communication, buildings for rehabilitation, social improvement by building schools, healthcare facilities, training of local people engaged in the project, etc. Although not directly related to projects, such social activities need a lot of money and time. Without these development activities projects would not be supported by the local stakeholders. Project Authorities have to convince the local people about the utility of the project by convening meetings and publicizing the developmental activities.

5.0 Chamoli Valley Flood Disaster

The flash flood disaster in the Chamoli District of Uttarakhand which occurred during February 6th -7th,

Figure-2 Chamoli Flood Disaster – Map showing Rishi Ganga and Dhauli Ganga Rivers (Source: Google Image)

2021 serves as a stark reminder of what can happen if the risks associated with a hydro-power project are not completely enumerated, addressed and mitigation measures put in place for future developments. The debris, rock, and ice flowed downslope in the form of an avalanche, it killed at least 32 people instantly and trapped 150 workers in the underground tunnels, it washed away some villages and wiped out newly constructed barrages and bridges and damaged two power projects in the Tapovan area of the District (Figure-2).

6.0 In Depth Analysis of the Chamoli Flood Disaster

In all likelihood, a steep, hanging portion of the Nanda Devi glacier broke off at Trishuli - what is called a 'rockslope detachment'. This caused nearly 2,00,000 square metres of ice to drop 2 kilometres almost vertically, resulting in snowmelt and landslide, impacting the valley floor and shattering structures instantly. The debris, rock, and ice flowed downslope in the form of an avalanche, identified by the dust trail in the satellite imagery. Additionally, there was likely more ice-cored moraine, or ice covered by sediment, as well as stagnant glacial ice downstream (Figure-3). These large volumes of ice, spanning nearly 3.5 km further downstream melted due to the heat generated by the landslide and avalanche leading to the huge volume of water that flooded down the rivers –Rishiganga and Dhauliganga (Figure-2) which resulted in a sudden rise of the high flood level, very high flow velocity and stream power that caused devastation downstream.

Sometimes glaciers on mountain tops and the sides of mountains build up on account of snow that accumulates from snowfalls. The glacier becomes heavy and unstable and moves when the accumulation goes beyond a certain point. Besides, that there are the deposits of morains and ice often create natural dams (which contain melt water within) forming lakes upstream. Failure of such overladen glaciers or the loose dams because of overflow and sometimes puncture/ breach due to excessive water pressure from water, lead to sudden discharge and consequent flooding downstream.

Figure-3 Left - Snow Fall and Soil Erosion, Right - Avalanche Flow Damaging Barrage
(Source: Google Image)

These phenomena are known as Glacial Lake Outburst Flood (GLOF). Such a GLOF had also occurred in the Kedarnath valley in Uttarakhand in 2013 (Mazumder, 2014) and resulted in the washout of Kedarnath town and instant death of about 3000 people. It also washed away other habitations in its path. Breaching of moraines can be triggered by avalanches, earthquakes or a natural collapse of moraines. The latter was originally suspected to have occurred in Chamoli flood. However, it is not yet clear as to what triggered the original landslide that led to the disaster. Newer satellite imagery, survey data, and further investigations are expected to reveal more information about Chamoli flood disaster that occurred during 6th -7th February 2021.

6. Conclusion/ Recommendation

Electric power is essential for the upliftment of living conditions and hence there is an utter need for hydro-power development in the Himalayan region in India. The untapped hydro-power in the northern and north eastern states are 55.5% and 92.8% respectively. Unlike thermal and nuclear power, hydro power is flexible and highly efficient, especially to meet peak load demand. Ideally, the share of hydro-power in a hydro-thermal mix should be about 40%, whereas the current share is only 17% in India. Although hydro generation needs high initial investment and is time consuming, its maintenance cost is negligible in comparison to thermal power. Besides, there is no consumption of any natural resources and it does not cause any environmental pollution.

Hydro-power development in the Himalayan region through run-off the river type schemes is opposed by the environment lobby in our country on the ground of ecological damage and risks involved in flood disasters due to landslides induced by earthquakes and avalanches in the Himalayan region. Risks are present in all walks of life and so also in engineering projects. The objective should be to assess, analyse and plan credible mitigation strategies to contain or minimise such risks through adequate investigations, data collection and analysis, appropriate planning, design, construction, maintenance and monitoring – physical and remote with predictive analytics. Use of satellite imageries for investigating, monitoring and providing prior signalling of such phenomena should be adopted, considering the great potential of hydro-power and communications need for the development of north and north-east region of India. Recently, the Supreme Court of India approved one and half lane wide road in the Himalayas to connect with Char Dham and the Defence installations in spite of stiff opposition from the environmental lobby. It should be emphasised that natural events like floods, earthquakes, hill slides, glacial breaks and movement,

etc. occur even when there is no development like hydro-power, roads, etc. Hence, keeping in mind the fragile nature of the geology of the Himalayan region, it is recommended that institutions exclusively devoted to glacier and mountain research should be established in India, with a view to study, monitor and predict probable occurrence of natural disasters like those that have occurred in the Chamoli valley in 2020 and the Kedarnath valley in 2013 in order to minimise risks and forecast their occurrence to mitigate/ minimise damages from them.

Hydro-power is one way to help achieve the United Nations Sustainable Development Goals viz. SDG Goal 7 which is to "Ensure access to affordable, reliable, sustainable and modern energy for all" and as a consequence SDG Goal 8: "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" and the SDG Goal 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" and others as well.

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Risks and Resilience in Engineering Design of Process and Power Plants

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Synopsis

Plants, be they Process plants Industrial plants or Power plants, they are all subject to minor or major disturbances during their life cycle which can result in disrupting normal plant operations which has a cascading effect on the infrastructure, economic activities, and the community. Hence, Risk and Resilience strategies are necessary for all plants. They must include compilation of predictable risk assessment or disturbances as a key element, comprehensive analysis, strategic corrective actions to be adopted for system revival to enable optimum and continuous plant functioning. This article presents a brief introduction followed by an integrated design concept to ensure reliable system designs.

1. Introduction

Engineering design is extensively being understood as a systematic mathematical approach to solve complex problems including conceptualization and further optimization of process or systems based on available information in pursuit of attaining maximum efficiency. System engineering is modified incrementally adopting a previous trusted approach, thereby, encompassing new information as a calculated risk during design process. Risk is identified as anonymous, uncharacteristic low probability occurrence(s).

Mitigation of risk in industry is gaining increasingly more importance considering the following:

a. Effects on climate change, natural disasters like earthquake, tsunami, volcanic, seismic , etc. and manmade disasters like deforestation, reclamation, urbanisation, etc.

b. Latest trends of integrated engineering of similar capacity plants or multiple plants in the same complex like a, oil refinery generating various refined products like benzene, butadiene, petrol, diesel, kerosene, gasoline, etc.; Off-gases from refinery utilised for generating power using boiler and steam turbine generators; the exhaust gas from a power utility is fed to flue gas desulphurisation unit before exhausting to the atmosphere considering statutory requirements and ensuring minimal environmental consequences.

Resilient design considers all forms of inherent uncertainties namely internal variation and dynamics, shock and external drives. “Resilience” means the ability to foresee and organise, adapt to fluctuating situations and survive, respond to, and recover swiftly from disruptions. Modern management of risk emphasises on methodical planning, design optimisation and predictive maintenance reducing plant downtime and minimising spurious plant trips, by diminishing associated liabilities based on domain expertise and software simulations. The built-in system resilience utilising artificial intelligence tools and advanced diagnostics ensure faster response time and better adaptability besides also ensuring continuous

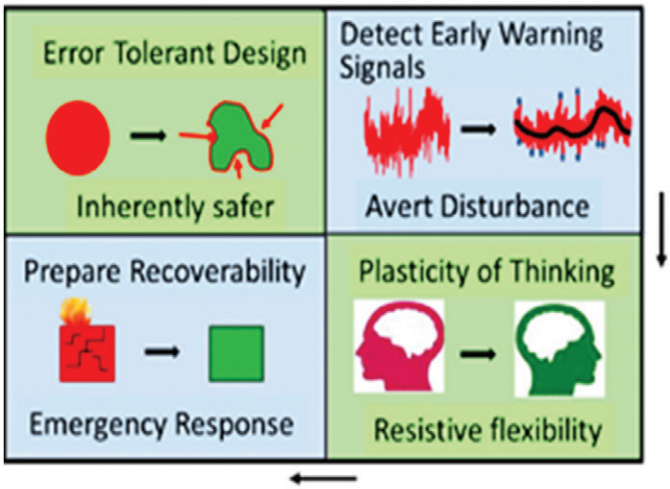

Figure A: Elements of Resilient Design

plant operation and prevention of spurious trips. However, these require that the design knowledge be upgraded continuously. Designers must be trained to optimize design and not be reluctant to challenge incompleteness of any sequence and associated nuances in projects which could lead to implementation delays or improper plant operations.

Complex engineering design are coupled to natural and social systems and are thus in a perpetual dynamic state, since they are affected by both external & internal forces. It is possible that a few hazards may not be captured during a risk analysis, hence only a risk approach is insufficient to ensure a fail-safe design. Consequently, add on resilient thinking is gaining significance in the engineering context. The Elements of Resilient Design are depicted in Figure A.

2. Engineering Plant Controls and Risk Analysis

The Risk Management process is applied initially during the Design phase so that a systematic approach for integrating plant design and risk management is followed. Risk Analysis is generally a repetitive process involving brain storming sessions with relevant industry design experts and plant operating personnel to evolve risk mitigation control measures to design a safe operational plant. The control measures incorporated into the system design should be reviewed during plant operation by operators to determine if there are any more risk(s) to be addressed and then eliminate them by design augmentation. This process enables identification and evaluation of all plant hazards and enables controlling of risks.

The basic engineering design steps include:

- Developing an initial design
- Evaluating the design for hazards and risks
- Redesigning to control/ remove risks and review design practicability extent
- Final design and preparation of risk control plan for the life cycle of the plant.

The designer may use the relevant technical and engineering standards to meet codal and statutory regulation requirements, however, that does not prevent the designer to evolve new systems and procedures.

The most widely used tools for risk analysis and design optimization in use are:

- Hazard Identification Studies
- HAZOP Study
- FEMA Analysis (Failure Mode and Effects)
- Pipe Stress Analysis
- Structural Analysis
- Smart software wherein data are interlinked through smart tables for repetitive data being used in multiple products of the same project ensuring data correctness and time saving by avoiding multiple entry of same data.
- Safety Integrity Level Study
- Safety Instrumented System Study
- Fault Tolerant Design
- Fail Safe Design
- Electrical System Studies
- Use of Drones to collect data of existing plants for revamp projects and so on.

3. Resilience through Risk Management in Plant Systems

a. Resilience

As per the International Council of Systems Engineers, Resilience is defined as "The ability of providing necessary capability during adverse situations". Resilience is thus the antidote for Risk. Risk thus pertains to value loss caused due to uncertain events, whereas Resilience relates to the design of a system to a pre designed capable level considering anticipated disturbances so that it regains an acceptable level of functionality.

Resilience perspectives are of two types – Reactive and Proactive

Conventionally, resilience is defined as a reactive concept - study of a disturbance effect on a system. Ecology and material science play a major role in the study, however, during engineering, resilience is adopted as a proactive perspective considering the threat that could be encountered and events prior to that. Resilience principles as far as Design Engineers are concerned are of two types based on Physical and Process principles. Physical redundancy in a system should have identical branches with same and equal functionality – classic example is communication system with two similar and independent branches. Process principle implies system alternatives or redundancies – as in electrical systems which have the designed capability to limit cascade failure by planned/ internal delays at nodes.

Resilience requirements are evolving in a scalable environment and are diverse in nature. Consider a minute system fault which could cascade across systems e.g. failure of a critical electronic component of a control system can trip the whole plant. The system should also ensure fool proof cyber security to mitigate threats or intrusions.

In addition to the above there are other measures of enhancing system resilience ability such as:

- Prediction/ Forecast of Potential Faults
- Isolation of impacted Components
- System protection from Potential Faults
- Fault removal and Recovery from a Fault state, and
- Optimization of Performance in Systems.

Resilience is quantified in terms of system availability at any instance of time. It is thus a function of continuous delays due to fault occurrence and the recovery speed from a fault state.

Fault tolerance is the ability of system to tolerate faults and continue to support. Hence, the important metrics for a control system's resilience are MTTF (Mean Time To Failure) and MTTR (Mean Time To Recovery). A third metric is MTBF (Mean Time Between Failures) which is a mathematical simulation of MTTR and MTTF. A redundant configuration is chosen to obtain the highest MTTF and lowest MTTR in addition to an optimum cost system with minimum complexity.

Reliability refers to probability of performance of the intended task by the system component in a specified time and duration. As noted above, a redundant system enhances performance and reliability of the plant, however, various studies have shown that there is an increase in the system cost due to redundancies which necessarily must be built into an equipment and the system.

b. Resilience and Redundancy

Resilience and Redundancy establish fault tolerance within computers, control systems and field instrumentation domain. Hence, they are allowed to be functional despite the occurrence of events like power outage, overload and other causes of downtime.

In the context of the design of the Control Systems:

- Redundancy is a designed intentional duplication of control system component to increase a Control System's availability.
- Resilience refers to a Control System's ability of fault recovery and maintenance persistence when in service.

As seen, Resilience and Redundancy are complementary but are not interchangeable in terms of definition.

Redundancy enhances a control systems resilience and resilient systems ensure that after fault occurrence, the redundant elements return the system to a functional state. The redundant configurations that are typically adopted are Active, Passive, Homogenous and Diverse redundant control system. Active redundancy is implemented in most systems wherein the components participate in the operation and share workload distribution thus facilitating recovery in case of a fault in one of the paths. Redundancies are deployed in Control System based on availability requirements, process complexity and cost.

Redundancy is one of the critical measures to enhance resilience, facilitating reactive or proactive response for effective positive change in the system.

4. Improve or Build Resilience in a Control System

Most designers think that redundancy is the only method of achieving higher availability. Availability is defined as the likelihood that a Control System operates effectively when required. Availability is experienced as availability one minus the unavailability. Actually, redundancy increases the number of components which naturally increase the number of potential component failures. Hence, designers should be aware that, if redundancy is not applied scientifically, the availability of the system could decrease due to introduction of multiple failure points in the system. With improvements in Control System technology and design, an optimum combination of both redundant and non-redundant methods for achieving high availability of a Control System needs to be maintained.

The redundancy component required to achieve high availability of a Control System are redundant Power supplies, Processors, I/O modules, HMIs Network, Servers, Sensors and Actuators for all critical applications.

Where a shutdown could cause a major loss of revenue or loss of equipment, human injury or disruption to public services, when a primary equipment fails – redundant equipment is necessary and essential to take over instantaneously by bump less transfer and enable seamless operation of the plant.

In Control System for process plants designer can achieve a higher availability through appropriate design. Likewise, they should accept the fact that any component can fail and design the system on the basis of a common reliable Control System. A process or power plant should be designed to run even if one of the equipment were to fail. This design is often called modular distributed design and involves area covering:

- Distributed control configuration/ architecture
- Distributed intelligent Human machine interface, data base
- Distributed Control Design with independent line, zone, etc.

Though advance Control Systems are available in the market, the problem encountered by a Control System design engineer and also Regulation agencies is non-availability of a precedence and validated design integrating multiple state-of-art technologies into a consolidated single system. Apart from the complexity of resilient control system, the design used in existing plants is somewhat different for different industries. The Control System design varies for Thermal power, Nuclear and Petro-Chemical plants due to criticality of process, environmental and safety requirements.

The objective of a designed resilient control system is to enhance a plant's critical Control System to survive when subject to adverse operating conditions, such as natural disasters, degradable factors, human errors, malicious attack and environmental changes. Resilient Control Systems are meant to work robustly and manage modification of ambiguous and sensor measurement inaccuracies in accidental or normal conditions. These design characteristics take preventive actions when nascent failures are identified. To convalesce from failure of sensor, actuator, final control element, communication network and to return to fail safe status

after accident, various technologies are used in resilient control design to achieve the requirement. A few of the technologies are given below. They are to be used after studying the scenarios:

a. Resilient System Controls Coupled System

A critical Control System needs a resilient control design which is generally costlier and complex. These are physically distributed but operationally coordinated sub-systems as in Nuclear plants, Electrical sub systems, Petro chemical complexes. In these cases, integrated Emergency Shutdown System and Plant Control System are considered.

b. Self-Aware Resilient Control System

Control Systems are designed with capabilities of detecting failure and predicting incipient failure after due verification, so that preventive actions could be taken. Technologies, with Fault Detection Diagnostics and Prognostics have capabilities to detect or predict a fault within the system.

c. Networked Resilient Control System

In a Resilient Control System, when a fault detection or accident warning alarm is given, immediate response needs to be taken through the correct action. In case a fault or an accident in one sub-system requires another sub-system to take appropriate corrective action, the selected Resilient Control Measurement is preferred to be through a networked Control System of the various sub-systems so that the supervisory control system can share critical information in real time to facilitate interoperability as required.

d. Distributed and Hierarchal Structure/ Architecture

In some plants, due to limitation in the information capability provided by the network Control System, Resilient Control is designed as a Hierarchical Control System Architecture to coordinate the response of sub-systems to harmonize the variation in various operation conditions.

e. Redundancy, Disparity and in-depth Defense

Redundancy, Disparity or Diversity and in-depth Defense are considered as design criteria in critical process and power plants. In general, all critical sensors components, actuators in control and protection system have redundancy, by incorporating features like prognostics, diagnostics, networked information sharing with adaptive and a reconfigurable Resilient Control System.

f. Protection and Recovery System

Protection and Recovery systems are final barriers of defense in Resilient Control Systems. These systems are designed to prevent all the critical assets from disastrous failures. Meticulously designed and implemented protection/ recovery Control Systems should be as simple and logical as possible and extremely reliable; they should protect systems where severe accidents could occur by mitigation of adverse effects when accidents occur beyond design purview.

g. Robust Design of Resilient Control Systems

Robust and smart control design mitigates conflicting effects of design modelling errors and unpredicted errors in normal operating circumstances, thereby decreasing the challenges of numerous layers of defense which thus improves Resilient Control System survivability.

h. Adaptability and Reconfigurable Resilient Control Systems

Adaptable and Reconfigurable Resilient Control Systems provide additional layer of defense in depth. In their case, preventative action would significantly reduce the adverse effect of failures of sensor and actuators which may be caused by ageing, natural disasters, human errors and malicious attack.

5. Conclusions

Risk Analysis based Resilient Engineering is part of a progressive adaptation process to alleviate risk and reduce the impact of major catastrophe – if unchecked. It necessitates identification, evaluation, solution development and promotion of best-validated practices. That is of utmost importance, especially for the

protection of critical and aging plants. Its applications are global, covering all industry sectors which require an integrated and systematic approach.

Key features of resilience assessment or engineering are tailor made for each project based on risk, threats, disasters and consequences of a disaster. Today using latest engineering solutions, designers can analyse, model and simulate multiple impacts or cascade effects to identify optimal design coupled with cost benefit. The right engineering design team with adequate knowledge, complexity awareness and experience should be engaged for Resilience Engineering design. Analysis of multiple risks and threats require multi-disciplinary skills and support across all phases of a plant's lifecycle.

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Guj govt approves project to provide additional 10 lakh acre feet of Narmada floodwaters to arid Kutch

Ahmedabad,Jul 5 (PTI) The Gujarat government on Monday approved a project which aims to provide additional "one million acre feet" of the Narmada floodwaters, overflowing from the Sardar Sarovar dam, to the arid Kutch region. Chief Minister Vijay Rupani has given an in-principle nod to various works worth Rs 3,475 crore to be carried out under this project, an official release said, adding the Water Resources department has been directed to start the works at the earliest. The project envisages to fill up 38 dams along with several check dams and lakes in Kutch district with the additional Narmada water, which will benefit the agricultural land spread over 2.35 lakh acres in 96 villages of Rapar, Anjar, Mundra, Mandvi and Bhuj talukas, said the release, adding the project will also recharge ground water. As per the state government"s estimate, 3.80 lakh people from these six talukas would reap benefits of this ambitious project. The water from the Narmada river would help farmers in not only irrigating their crop, but also for growing fodder for their cattle. This project would also stop the migration of cattle rearers of this region in the wake of weak monsoon, as they would not face shortage of water, said the release. PTI PJT NSK NSK

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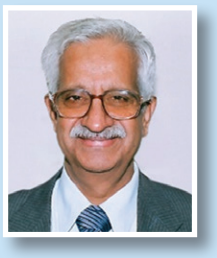
Report by A P Mull on the Technology Day Lecture delivered by Prof. V S Ramamurthy



Prof. V S Ramamurthy

To celebrate Technology Day on 11th May 2021 the Indian Nuclear Society had invited Prof. V S Ramamurthy to deliver a talk on **"A DECADE AFTER FUKUSHIMA DAIICHI NUCLEAR REACTOR ACCIDENT".** Prof. V S Ramamurthy is a recipient of Padma Bhushan, former Secretary Department of Science & Technology, Government of India and Emeritus Professor, National Institute of Advanced Studies, Bengaluru.

Prof. Ramamurthy not only talked about that accident but also succinctly put forth the strategic considerations that have enabled China to advance by leaps and bounds. I was very fortune to have attended that and learn from his experience and analysis. For the benefit of the readers of ViewPoint the same is being shared with emphasis on the strategic aspects.

Prof. Ramamurthy said that 11th March 2011 is an "important day in the history of nuclear energy for common good, electricity generation", since 10 years ago a major nuclear reactor accident at the Fukushima Daiichi power station in Japan was triggered by a massive tsunami. Although the "deaths directly ascribable to the reactor accident were very low (as low as 1), the environmental impact of the accident was considerable." He added that currently, a "major international controversy is brewing on the release of more than one million tons of contaminated water from the destroyed Fukushima nuclear station into the sea." He went on to say that across the world, the accident created a major impact on the public perceptions of the safety issues related to electricity from nuclear reactors.

Prof. Ramamurthy traced the development, the expectations of electricity generation from nuclear reactors and then the reaction leading to restrains imposed by countries after the Fukushima accident. While Japan shut down all nuclear reactors to carry out a detailed safety review, Germany's was a panic reaction which led to them to "embark on an 'exit' plan from nuclear energy". However, India, Russia, China, and South Korea who recognise that "nuclear power will remain necessary to plug the gaps left by renewables in the energy mix of the future and are moving forward with their nuclear energy programmes while strengthening their safety and security infrastructures." "Some countries simply slowed down their nuclear programmes, keeping a watch on the global developments. Countries like the USA and Canada are keeping an 'open mind'." He spelt out the status of the nuclear reactors and the allied industry in the two countries and added that "no new reactors are under construction as the plans for installations of four reactors either lapsed or were deferred. With only a few nuclear reactors coming up in the last several decades or being planned, their nuclear education and research are in the doldrums and their nuclear industries are in the doldrums. It is strongly felt that in the process, they are indeed losing their leadership positions to other

countries." He raised an extremely important question "Are these countries giving China a global leadership position in the area of energy on a platter?"

Prof Ramamurthy recalled as to "how China was handed over the leadership position in rare earth magnets by US in the recent decades."

"The Rare Earth story: Today, China produces over 90% of the low-value and up to 99% of the high-value Rare Earth Oxides for world consumption and controls 97% of the global rare earth market while its rare earth resources account for only about 37%. Till very recently, the US was the leading producer of rare earth magnets. By a set of carefully executed strategic moves, China transplanted America's most advanced rare earth capabilities into China and converted it into their national monopoly. India has the world's fifth-largest reserves of rare earth elements, but it imports most of its rare earth needs in finished form from China. How did it happen?

Until the middle of the last century, most of the world's rare earths were sourced from sand deposits in India and Brazil. Through the 50's, South Africa came into the market and then through the 60's, 70's and 80's, the Mountain Pass rare earth in California was the leading source. In 1986, for some reason, which can't be just without a basis, the Chinese government placed rare earths on the list of national priorities, and in 1992, Chinese Premier stated to the world, "the Middle East has oil, China has rare earths". By 1997, the rare earth producer in United States was forced to stop mining. Why? Under increasing pricing pressure from China! They basically outbid them in price and, of course, there was help from the United States itself, environmental pressure from the State of California, leading to stoppage of all operations by 2002. In 2003, China acquired one of the most advanced rare earths magnets facility in United States including its portfolio of patents, closed it, transplanted the entire plant to China in 2003. Now, while the company was being brought to China, they also trained the required manpower. In less than 30 years China had made rare earths into a national monopoly!

The Chinese were also using a mixture of restrictive production, export policy, tax regime on rare earths, with the basic objective of shifting more and more rare earth technology-dependent manufacturing facilities within the borders of China.

Japan had a taste of this near monopoly policy when Beijing halted shipments of rare earth magnets to Japan, over a territorial dispute related to fishing. Now, of course, efforts are being made in the United States and elsewhere to catch up with China in this field but this is not going to happen overnight because they had closed their factories, dismissed their manpower and there is nothing left there of the earlier operations. They have to start all over again when 97% of the market is controlled by China. Does it matter? Yes, it does. It is said that anything that moves or rotates has a magnet inside, a rare earth magnet. Whether it is a wind turbine, an electric automobile, an industrial machine, magnets play a part. It is not surprising that China is slowly inching towards leadership position in all these sectors.

Where is India in this game? In the 50's, we were a major source of rare earths. I have heard that Patiala was supplying a bulk of miniature motors for tape recorders. Today, they have become irrelevant.

I also remember that in the 90's, there was a proposal to have a Titanium plant in India and it was scuttled because it was not economically viable because of the cost of production was more than the cost of the Chinese Titanium. What is the manufacturing cost in China? God only knows! Their marketing is what we need to understand. They closed the Titanium market last year, and I understand some product prices went up by a factor of 10.

We actually stopped producing rare earths in 2004 due to lack of market competitiveness. Talking about competitiveness in the market and taking a policy decision like closing that activity is not a great strategy. Of course, now we are trying to revive our capabilities to become competitive once again both through indigenous efforts as well as with international co-operation, for example with Japan. Now considering

that India has a major stake in renewable energy and major ambitions in the automobile sectors, both of which require rare earth magnets, it is indeed surprising that we did not have a policy on rare earth minerals. But perhaps, it is not surprising because we rarely have any strategy in the market place.

In a very similar development, China was handed over leadership position in PV modules. China today produces more than 70% of the global needs of PV modules.

Hydrocarbons like oil, coal and natural gas have been the backbone of energy across the world for a long time. Having committed to a migration to renewable energies like solar and wind as a part of the global efforts to de-carbonize energy production, China has made considerable progress in renewable energy technologies.

World Ranking	I	II	III	IV
Hydroelectric (www.statista.com)	China	Brazil	Canada	US
Wind (www.nsenergybusiness.com)	China	US	Germany	India
Solar (www.nsenergybusiness.com)	China	US	Japan	Germany

Renewable energy resources like solar and wind are highly intermittent- depending upon the time of the day, month of the year, and the weather. These draw-backs are sought to be overcome with the use of electricity storage batteries and pumped-up storage systems. Battery systems are highly material intensive [8], and they are neither cheap nor environment friendly in the long run. We would also like to emphasize the fact that the capacity factor of most of the renewable sources of energy is also rather low [10]. It is about 24% for solar power plants, 35% for wind power, and close to 94% for nuclear power plants. Considering all these, there is a general consensus that one should include some fraction from nuclear power stations as a base load while migrating to renewable energies. Understandably, China has also invested in nuclear technology for electricity.

China is investing in nuclear energy precisely when countries like US, Canada are stepping back.

Is the world giving China a global leadership position in nuclear technology too on a platter? China didn't have to fight any war to reach this position.

For a long time, India and China have been running on parallel tracks, developing economies with weak educational and industrial infrastructures."

Prof. Ramamurthy then showed a comparison of the Gross Domestic Product of three economies - US (developed economy), India (developing economy) and China to show "the dramatic change that is taking place in China's economy since the beginning of this century. It had also been noticed that manufacturing, and not Services, accounts for bulk of this GDP rise. How did this happen?

How many of you are aware that China gave a major boost to education, research and an ecosystem for innovation and entrepreneurship during the very years when the GDP was recording a rapid growth?"

He added that "It is interesting to note that China has already overtaken the US in terms of the total number of Science publications. (Nature 553, 390 (2018)).

How did this happen? Essentially following the US model, China made two investments:

1. It invested in education and research.
2. It invested in creating an environment for innovation and entrepreneurship.

The TORCH Program:

The TORCH programme under China's Ministry of Science and Technology (MOST) is the programme that kick-started Chinese high-tech innovation and start-ups. The programme had four major parts: Innovation clusters, Technology Business Incubators, Seed funding and Venture Guiding fund.

The first Technology Business Incubator was established in Wuhan in the year 1987. Today, China is

home to several thousand incubators and makerspaces. More than a few hundred thousand small and medium size enterprises came out of these Incubators and makerspaces. China has ambitions to further increase the number of incubators and makerspaces including a few incubators overseas."

Prof. Ramamurthy talked of China's Project 211 (1995) "aimed at strengthening about 100 institutions of higher education and key disciplinary areas as a national priority for the 21st century." The other is Project 985(1998) "a constructive project for founding world class universities for the 21st century." He went on to say that "China has also declared its ambition to lead the world not only in Science and Technology but also in Design and Manufacturing of technological products in the next two or three decades. As mentioned earlier, in selected areas of high technology such as rare earth magnets, solar photovoltaics and power electronics, China has already wrested leadership roles from other players such as US and Germany in the recent years. They are also moving forward aggressively in several other areas such as genomics, Artificial Intelligence etc."

He then explained the Double First Class University Initiative (2018) which "has the same goal as the earlier Project 211 and Project 985 to strengthen Chinese Universities and the educational system but to International levels. 42 Universities and 95 disciplines have been identified for the first batch through a series of competitive selection."

Summing up Prof Ramamurthy said that "The message is very clear- invest human resource development to carry out R&D in identified areas of national importance (Bhabha model) and built an ecosystem for innovation and entrepreneurship to convert knowledge into wealth, effectively following the US model. (Bhabha didn't live long enough to put in place the Innovation and Entrepreneurship as a part of our training programme)

I won't say that we have been sleeping. We built over a period of time, a reasonably good educational and research infrastructure. And in selected areas, as in nuclear technologies, we have achievements to our credit. Thanks to the Bhabha Model (BARC Training School and today's HBNI), we survived the technology denial regime of the seventies and eighties and the global competition following the economic liberalization of the 90's. In the absence of an ecosystem for innovation and entrepreneurship, we lost a good number of our best of brains to migration. The question which we keep asking ourselves is whether at the rate at which China is moving in the science and technology led growth and the rate at which India is moving in the same path, India can survive Chinese competition in the coming years?

What India needs to fix to retain our rightful place in the global space (one sixth of the world population)?

1. We need to fix our educational pipe line and bring more people into R&D. For every million population, US has about 4660 researchers, China has about 1177 researchers and Finland has 7700 researchers. In contrast, India has about 216 researchers. This has to be corrected. China has shown that the payback on this investment is almost immediate.
2. We need to strengthen our ecosystem for Innovation and Entrepreneurship.

China and India ventured into technology based innovations and entrepreneurship band wagon approximately at the same time. (1987-90) with support from United Nations Fund for Science and Technology (UNFS&T). While the Chinese program moved forward, the Indian program was almost dormant till 2000 when India started its TBI program with a clear policy strategy. By then, China had already established nearly 200 TBIs. By the end of 2009, there were approximately 120 TBIs in India."

Ironically, five Indian experts from the Entrepreneurship Development Institute, Ahmedabad, employed by UNFS&T, played a major role in preparing the Chinese program of Incubators and one of them, Dr. Rustam Lalkaka continued to be a leading consultant to the Chinese incubator program.

Let me conclude with a dream:

The Bhabha model has worked well for our nuclear program. Let us scale it up. I am aware that DAE has several Training Schools in multiple locations. Let us have more HBNI's across the country.

The Bhabha model did not have any provision to encourage Innovation and Entrepreneurship. Let us establish a TBI in every HBNI to encourage innovation and entrepreneurship."

The message by Prof. Ramamurthy is loud and clear –

Strategic Decision making is a dire need for India and decisions should not be guided by short-term Financial considerations. India's Policy decisions must be to ensure the Development, Growth, Sustenance, Safety and Security of the Nation. For that to fructify India must have many more Scientists, Technologists and Engineers and Research Institutions to break the barriers of poverty, backwardness and dependence on foreign resources and become a leading Nation.

Acknowledgements

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I also wish to thank the Indian Nuclear Society for arranging the event and permitting its mention in ViewPoint.

Researchers at IISER Bhopal to study atmospheric CO emissions

Innovative data model fusion technique aims to dramatically improve air quality over India

The COVID-19 pandemic has demonstrated the urgent necessity for a low carbon economy to improve air quality, energy resources and sustainable ecosystems. The unprecedented drop in the world's carbon footprint by 2.6 gigatonnes (Gt) — a magnitude very close to the total annual emissions of India — during the lockdown emphasises the magnitude of actions required at a global scale to combat climate change.

A team of researchers from the Indian Institute of Science Education and Research (IISER) Bhopal led by Dr. Dhanyalekshmi Pillai, who heads the Max Planck Partner Group (MPI-BGC Germany) at the institute, are attempting to address the climate change challenge by developing and implementing an innovative data-model fusion technique which aim to dramatically improve air quality over India.

This consists of an advanced high-resolution atmospheric CO (carbon monoxide) modelling technique, which is capable of devising strategies to address air quality issues faced by both agricultural sectors and in megacities across India, particularly with respect to Delhi, Mumbai and Bengaluru.

The team's research was recently published in one of the prestigious scientific journals of the European Geosciences Union (EGU).

Read full storey at :

https://www.thehindu.com/sci-tech/energy-and-environment/researchers-at-iiser-bhopal-to-study-atmospheric-co-emissions/article35168857.ece

CEAI NEWS

WORKSHOP ON 'ISO QUALITY CERTIFICATION FOR CONSULTING ENGINEERING FIRMS'

As engineering projects are becoming larger and more complex, multi-disciplinary, engaging multi-national teams spread across geographies, it is imperative that Consulting Firms have well-defined processes, systems and procedures that are well understood in the organisation. ISO 9001 is an international standard that set out the requirements of quality management systems that can be used by organisations to be more efficient, manage risks, improve customer satisfaction, effectively control operations and costs, and continual improvement in all areas of operation.

The online workshop on "ISO Quality Certification for Consulting Engineering Firms" held on April 15, 2021, was positioned as an introductory treatment of the subject for Consulting Engineering firms, particularly the Members of CEAI. Quality is a perceptual, conditional and a somewhat subjective attribute of a product or service. Quality is a key competency through which firms can derive competitive advantage. Achieving quality is fundamental in business and in propelling the business into new heights.

ISO 9001 is of fundamental importance for effective quality management. For external stakeholders to believe in the authenticity of the business, quality management systems are crucial, and proof of these systems being in place are a sign to customers that the consulting firm is trustworthy and worth doing business with.

The workshop broadly covered:

- What is a Quality Management System?
- Why do Consulting Engineering Firms require QMS?
- How is QMS implemented?
- When should a Firm get certified for QMS?
- Feedback from CEAI members based on QMS Survey undertaken in the recent past

The workshop was held under the aegis of the Ethics & Quality Committee of CEAI "To enumerate the various actions required to be undertaken to sensitise members and promote awareness about the need to improve the quality of services and provide error free deliverables, thus reducing Customer complaints .....CREATE A CULTURE OF QUALITY."

In the training conducted by Mr. Somenath Ghosh, Member CEAI there were over 150 attendees; the training had interactive elements for the participants through quizzes.

WEBINAR ON "HAZARDS & RISKS"

In continuation of the webinars on the theme of Safety, The Consulting Engineers Association of India (CEAI) through its Western Region Centre organized another one on 24th June 2021 to create awareness regarding "HAZARDS & RISKS". It was to draw attention to the hazards and risks that one faces every day and how to assess and mitigate them. The intent was also to introduce the realisation of consequential hazards that arise - referred to as multi-hazard scenarios. The webinar covered the daily scenarios encountered by the common person and moved on to what engineers encounter in their work repertoire - risks in engineering, contracts, multi- hazards whether natural or man-made and the insurance aspects to cover the risks.

Mr. A P Mull, Past President CEAI, Dr. Harshavardhan Subbarao, Chairman CEAI-WRC and Mr. Jeffrey Nambiar, Hon. Secretary and Treasurer, CEAI-Western Region Centre (CEAI-WRC) and other Members of the CEAI-WRC event team organised the webinar with the support from Centre for Workplace Safety and Health (CWSH), Mysuru, Tuli & Co. and Structural Engineering Form of India (SEFI) with the ready and timely agreement of the of all speakers.

Dr. Harshavardhan Subbarao, Member Governing Council CEAI and Chairman, CEAI-Western Region Centre, the Moderator introduced the theme and invited Dr. Ajay Pradhan, President, CEAI to give his opening address.

Dr. Ajay Pradhan welcomed everyone and emphasised as to "how important hazards and risks analysis and management are for projects to safeguard men and materials including plant and equipment." Giving a brief about CEAI, DR. Pradhan informed that CEAI is the representative body of the Consulting Engineers and also a Member Association of FIDIC in India. He stressed that "I believe hazards and risks are an extremely important aspect of our business practices, but they are very often not given due importance. See how the pandemic caught the world unawares. I am aware that most of the large consulting and contracting companies have a specialized team or a process to go through Risk aspects right from "GO or NO GO" stage of project bidding right upto project implementation. That team is also tasked with the responsibility to maintain a Risk Register for projects along with Health, Safety, Environment, Quality and Security (HSEQ&S), and there are different levels of risks including approval process from the top leadership. Therefore, it is most desirable that small and medium size companies should include risk analysis aspects into their HSEQ&S manual."

He also cited his experiences, one of the 330MW Kishanganga Hydro-Electric Project which inter alia comprised a 24 kms of tunnel in a difficult and remote location constructed and was done under a triparty agreement of Owner-Contractor-Consultant. A second example he gave was of the South Basin Hazira Trunk Gas Pipeline project that involved pre-engineering, post engineering, pipe laying, etc.

He mentioned that recently there was a research article published in one of the English daily about the 'Risks and Vulnerability Index' of waste generation and management in cities. That article highlighted that the organizations involved in urban projects would need to assess the hazards and risks aspects of their work and engagements.

Dr. Pradhan while concluding said "I am confident that the presentations and deliberations will address key issues and the challenges perceived by our fraternity including liabilities arising out of hazards and risks."

Dr. Subbarao then introduce Dr. N Krishnamurthy and invited him to make his presentation.

Dr. N. Krishnamurthy, Founding Director, Centre for Workplace Safety and Health, Mysuru; Safety Consultant and Trainer, Singapore set the pace with his

lucid presentation on ***"Hazards and Risks ... and What to do About Them!"*** Commencing his talk, he said that while Risk Management is "practised in most advanced countries and even in India by a number of major organisations" it was not known to or effectively practised by most enterprises in India. He advocated that it was "imperative that organisations in India adopt risk management as a tool not only to reduce accidents but also to boost productivity". He then clarified the difference between Hazard and Risk. "HAZARD is potential danger" whereas "RISK is actual danger, a hazard activated, exposed to, realised." and said that one "must assess risk, and manage risk, to reduce accidents, and their consequential harm and losses". He cited and showed examples in everyday life to clarify the difference.

Moving on to Risk Management he mentioned that "It is what we do instinctively, spontaneously, most of the time" for "our mind (both conscious and subconscious) will analyse the possible consequences of our getting into a potentially dangerous situation, and decide that we should take preventive measures against those consequences". He explained that "risk management is an art and science which is adopted by most advanced countries, primarily for most financial investments, but increasingly for industrial and other professional activities in engineering, medicine, etc."

To emphasise Dr. Krishnamurthy gave the statistics of Road Accidents in India in 2019 and drew attention to the fact that "Riding without a helmet has become so 'normal' that very few remember the possible dangers."

He explained Risk Management with reference to Two-wheeler Accidents, considering only human and vehicle errors, and assume (just to keep analysis simple) that the design of road and facilities initially meet specifications. He dealt with the Cause of mishap, Preventive safeguards, Mitigating safeguards and Mishap Consequences. He moved on to the "Bow-tie or Butterfly Diagram for Risk Analysis" and linked Causes – Preventive Controls – Mitigating Controls and Consequences.

Enumerating the reasons as to why people take Risks, he listed "Ignorance, Negligence, carelessness, Necessity, Livelihood, survival, Hobby, Fun, Entertainment, Fear, Self-destruction, Profit and GREED".

Dwelling into more details as to Why Risk Management he said that it was for the "same reasons as we: Read the weather report, Go for a medical check-up, Stretch out hands walking in dark, …Namely, to think about what (if any) bad things may happen and avoid them or protect ourselves from them as well as possible."

Moving on he spoke of the "Reasons for – and benefits from – risk management are to: Identify hazards, assess their impact and develop controls to avoid or mitigate the consequences from the hazards; Ensure workers and others at site will be protected from risk; Enable meeting all legal requirements; Facilitate appropriate optimum, and realistic, planning of solutions to promote safety, economy, and productivity; Improve personnel morale, and image of the organisation;" and above all "Serve as a predictor – a warning – about possible risks so that we may plan to avoid/ reduce accidents, hence injuries and deaths." To make his point that Risk Management leads to Fewer Accidents he gave examples of the Lesson Learnt and moved on to Identifying the Hazards around us – "There are many hazards we don't recognise, and don't care about: Foods we eat, Air we breathe, Water we drink, Roads we walk or drive on, Pedestrian crossings and Escalators and lifts.' He then added that "This 'Awareness' is what we need most, we must develop first, because without it, we will ignore or neglect the dangers we face."

Dr. Krishnamurthy then queried "Once we now the Dangers, then what?" and his answer to that was "must understand the full consequences of being ignorant or negligent of the hazards and developing risks." He gave an example of a building collapse and moved on to the next step "After Understanding the consequences …?" He explained that it involved "estimating the consequences under different conditions". Since it is not

possible to prevent or protect from all one must do what is reasonably practical.

Talking of how to do Risk Management, he talked of" the four steps: Identify credible and pertinent hazards in a specific job or task; Assess the levels of risk components arising from the hazards; Combine components to determine risks and categorise them; and Eliminate or mitigate risk consequences by appropriate controls." Next, he talked of that "To assess the levels of risk components and risk categories," determine whether each of the event or situation is "(a) Acceptable, in which case, we leave it alone; (b)Tolerable (or Manageable), in which case, we decide and implement ways of controlling it to within our resources; or (c) Unacceptable, in which case, we must find a way or either letting a better-qualified entity to do it, or lower risk to (b, or c)."

He stressed that "risk management is not a "One-size-fits-all" technique" since it depends on the Industry, Organisation, Project, Task, Material, Financial, & Personnel resources of the organisation; and the applicable regulations and legal requirements.

Dr. Krishnamurthy then explained how to assess risk components and risks based on the two most important factors – Likelihood and Severity. He then moved on to how they were plugged in to a 3 x 3 matrix of Low, Medium and High. If it is Low Risk - Don't worry about it but if it is a High Risk – Don't do it. However, if it is Medium Risk the Manage it. He gave examples of Crossing a Drain. He then explained what a Comprehensive Risk Matrix is.

The next were examples of Risk Categories on a Deca Scale for which three or more categories should be as already mentioned. He talked of those with reference to Office, Construction Site and War Zone.

Dr Krishnamurthy's message as summed up by him is

NEVER SAY "IT WILL NOT HAPPEN TO ME"
ASK INSTEAD:
"IF AND WHEN IT HAPPENS TO ME,
CAN I (OR MY LOVED ONES)
AFFORD THE CONSEQUENCES!"

At the end since Engineers are involved with Work sites and Plants, he also advised that Risk Control should be evaluated and recommended according to the order of effectiveness – Elimination, Substitution, Engineering Control, Administrative Control and use of PPE so that the Company and Worker are both Safe.

Dr. Subbarao thanked Dr. Krishnamurthy for his "lucid, cogent, coherent and for making even a common person who has no idea, understand the subject; like the great Faraday Lectures in the UK, for the common man, the most complex issues are given in an easy to understand manner." He then introduced the next speaker Mr. Uttam Sengupta and invited him to share his screen.

Mr. Uttam Sengupta, former Corporate Advisor – Risk & Contract, Voltas Ltd moved the scene from the everyday generally encountered hazards and risks to those that lie hidden in Contracts. Dealing with works contracts per se he defined "Risk" in a Contract as "a measure of inability to achieve overall project objective within defined cost, time schedule and technical constraints that may be embedded therein." And added that Risk has two components and hence it's a product of Event and Probability of Occurrence. He went on to say that there is no standard approach to Risk Management but for it to be successful it must "include: planning for risk management; continuously identifying and analyzing project events; assessing the likelihood of their occurrence and consequence; and monitoring project progress towards meeting project goals."

His answer to the question as to "Why Manage Risk?" was by way of Murphy's Law and hence Project Management is Risk Management. He added that "Ignoring the risk does not make it go away". Risk Governance & Management call for a process that "Protects the shareholders value; Eliminates surprises, and Fosters growth." He then said that the benefits of reducing risks were: "Fewer Surprises, More effective decision making, and Improved corporate governance."

The Risk Management Process involves 3 fundamental steps. "Risk Identification - What might go wrong? Risk Analysis & Estimation- What is the likelihood (probability) it will go wrong? and Risk Evaluation, Response Planning & Execution - What are the consequences (severity)?"

There are four steps for developing a "Risk Management Plan: Identify all the possible risk events that could affect the project; Assess each risk in terms of probability, impact severity and controllability; Develop a strategy and/or contingency for responding to each risk; and Monitor and control risks dynamically. A Risk Management Plan should be developed during the initial project phase and immediately implemented. The plan should reviewed & revised as needed during each project phase."

Mr. Sengupta thereafter outlined ten Steps for Effective Risk Management.

Step	Activity
1	Perform Risk Assessment before preparing the Schedule of Works
2	Cover all Qualified Risks in Schedule of Works
3	Adopt the Work Break Down Schedule to deal with all Qualified Risks
4	Replace unnecessary details in the Schedule with Activity Steps
5	Use Several Calendar to handle relevant Risks
6	Resource load the Schedule to Uncover Resource Risks
7	Look for Secondary Risks before Final Schedule Development
8	Monitor and Control Risky Activities by using Supplementary Tools such as: • Procurement Ladder • Tracking Logs • Activity Steps • KRI's (Key Risk Indicators
9	Add many Control Milestones to the Schedule
10	Plan Risk Response

He moved on to the Methods for Risk Response: Elimination, Transfer, Retention and Reduction. Thereafter he presented the methods for Risk Mitigation and Contingency Planning.

Talking of Allocation of Project Risk, he said that "If Risks are not allocated in the contract, then an arbitrator or ultimately a court would usually be charged with the task of that allocation and in doing so they might use one of four established criteria for such an allocation.

In construction contracts, risk allocation is based on the concept of control of the risk and/or its consequences. If the Risks are not allocated, then the four Maxims used by a Judge or an Arbitrator, either individually or in combination, consciously or unconsciously, are: Which Party can best control the risk and / or its associated consequences? Which Party can best foresee the risk? Which Party can bear that risk? And Which Party ultimately most benefits or suffers when the risk eventuates? He then explained how Economic & Time Risks in a Project are allocated.

Talking of the impact when the Project Risk eventuate, he said that there "could be one of two possibilities: leading to damage, physical loss, or injury, which is generally insurable; or Leading to economic and/ or time loss that is generally not insurable." He added that "The Allocation of project risks to the various parties in a contract has a significant impact on the type of contract form that one might appropriately use." He also explained how to Effectively Control Risks and the hurdles that arise while doing that. Concluding, Mr. Sengupta stressed that a proposed contract must be reviewed with a focus on the aspects given below so that Risks in a Contract are well allocated and controlled.

▪ Realistic project schedule	▪ Request for information (RFIs)
▪ Clarity of project definition	▪ Meeting requirements
▪ Supervision of staffing requirement	▪ Scheduling obligations (CPM)
▪ Right to additional compensation in the event of delays	▪ Limitations on mark-ups and reimbursable
▪ Right to additional compensation for changes or extra work	▪ Indemnity provisions
▪ Reporting requirements	▪ Coordination responsibility
▪ Scheduling requirements	▪ Suspension provision
▪ Review of shop drawings and submittals	▪ Liquidated damages clause
▪ Pay request administration	▪ Choice of law provision
▪ Change Order administration	▪ Final payment provisions
▪ Site observation requirements	▪ Post completion obligations
▪ Quality Assurance provisions	▪ Compensation commensurate with work and risk

While thanking Mr. Sengupta, Dr. Subbarao for emphasizing that all our work is enshrined in a contract and hence it is necessary to understand the contract document and how the risks are allocated and mitigated. All the issues mentioned were based on Mr. Sengupta's vast experience in dealing with contracts including global contracts. He added that the framework of the Contract document is very important for every Consulting Engineer. He then invited Professor Dr. Vasant Matsagar and gave a brief background about him.

Professor Dr. Vasant Matsagar, Dogra Chair Professor, Department of Civil Engineering, Indian Institute of Technology (IIT) Delhi in his presentation on ***"Multi-Hazard Considerations for Assets - Framework"*** introduced the concept of multi-hazards which in other terms implies (a) one hazard creating another hazard and/ or (b) effects of multiple hazards on the assets during their lifespan. To begin with, he stressed that there are engineered built infrastructures which are of importance and whose functioning has to be ensured during and post a disaster. Next, he showed non-engineered built-infrastructure and also engineered built infrastructures which have collapsed for various reasons.

Then, different multi-hazards for structures can be classified as being natural or manmade and said that the "main objective of control systems" incorporated in them was "to minimize the energy imparted to a structure, thereby reduce the damage" and showed some illustrations. Moving on to multi-hazard protective structures, he said that their behaviours were dynamic phenomena involving vibrations and hence response control was introduced. Their study was covered under "earthquake engineering, wind engineering, fire engineering, blast engineering, and protective structures; and advanced engineering materials and their composites: fibre reinforced polymers in prestressed concrete structures", which involved deterministic/ probabilistic approach or probabilistic/ stochastic approach. He then presented a global overview of hazard scenario which showed that India is prone to several geophysical and climatological events.

Dr. Matsagar next posed the question "Why Study Multi-Hazard?". To answer that, he projected photographs of destruction caused by earthquakes followed by massive fires; earthquake causing a tsunami and that resulting in nuclear accidents leading to nuclear contamination and radiation; hurricanes, cyclones, storms which are

accompanied by heavy rains and caused flooding of rivers, erosion of river beds, scouring of foundations, collapse of bridges and other surface connectivity infrastructure, apart from flooding in habited and rural areas; explosions in plant or non-plant premises causing damages to plant, equipment and structures, and their collapse at times plus fires, release of toxic/ hazardous gases; storm surges due by hurricanes, etc. which damage the coast plus flood the coastal areas and many a times fires also break out; etc. which all cause loss of invaluable life (human, animal) and property/ assets. The financial and economic losses are in the order of billions for every such event, which have been quantified by insurance companies and presented.

To drive home the point of the effect of the multi-hazards, he presented the statistic of "World Natural and Manmade Catastrophes 2015" which reports the number of events/ incidents as 155 for manmade disasters and 670 as the average of the last 30 years 1985-2014 for the natural disasters. The insurance losses are also much higher for natural multi-hazard events.

Stressing on the relevance and importance of multi-hazards on civic society, Dr. Matsagar said that a "single hazard affected around 19% of the world's land cover and more than 50% of the population; at least two hazards affect around 4 million sq.km of land area and more than 800 million people; more than 3 hazards affect around 0.5 million sq.km land area and more than 105 million people" since they have an "interacting or cascading effects on the structures/ assets, inflicting additional destructions."

He then talked of concepts for "classification of multi-hazard assessment based on probability of occurrence" and moved on to "identifying challenges and mitigating the challenges which have interaction and inter-relation effects". He talked of structural risk assessment which is on an innovation trail involving structural designers, code writers, key stakeholders, et al. and he stated the hypothesis – "multi-hazard (risk) analysis are not just the sum of single hazard (risk) analyses" after which he gave a historical overview of the multi-hazard scenarios in which early experimentation was on dams, bridges, offshore structures, etc. but was really triggered by the 1995 Oklahoma City bombing and gave impetus to statistical and probabilistic tools to quantify failure and build a "Multi-Hazard Resilient Community".

With that, he advocated multi-hazard assessment of structures and talked of the technical assessment of the assets following different methodologies, e.g., fast Fourier transform (FFT) spectra for typical earthquake and wind scenarios giving idea about vulnerability of the built infrastructure to some such extreme events; and the fragility and hazard diagrams used for risk assessment.

Dr. Matsagar presented and elaborated on the "General Framework for Multi-Hazard Scenarios". In explaining the framework, he stated, "determination of the study area; identification of the relevant hazards and acquisition of hazard information; determination of vulnerability indicators and collection of the data; weighting of factors and vulnerability assessment (including the display of vulnerabilities); and effect of hazard interactions on the overall vulnerability". He explained the Multi-Hazard Assessment Framework for earthquake- and wind-imposed loads on multi-storeyed buildings, as well as a deterministic response for a simplified Single Degree of Freedom (SDOF) system and explained how there was an "overlapped frequency band showing multi-hazard dominance". Hence, the "structure subjected to excitation within this overlapped band is vulnerable against multiple hazards"; and thus "it becomes important to characterise the modal properties of the structure". He also showed that in the probabilistic response also the structures with a specific range of fundamental frequency might be dominated by multiple hazards during the design (service) life of the structures. Thereafter he presented how a similar analysis could also be carried out for industrial structures and different scenarios of loading prevalent at such locations.

Dr. Matsagar, while summarising informed that, the National Building Code of India published in 2016, incorporated the terms "Multi-Hazard Risk Concept"

and "Multi-Hazard Prone Area" in Volume 1, Part 6, Section 1, Clause 9 in which the commonly encountered hazards in different states of India have been listed. Annex P (referred in Clause 9.2) gives a "Summary of Districts having substantial Multi-Hazard Risk Areas" and Table 53 therein lists "Multi-Hazard Prone Districts".

Dr. Matsagar concluded with the note, that site-specific and scenario-based multi-hazard analysis and design of structures/ assets will be recommended by probability-based codes/ standards in future.

Dr. Subbarao said that Dr. Matsagar had made "a very illuminating presentation and opening our eyes and our minds to what actually happens with multi-hazard situations that we need to deal with" and as mentioned there is a lack of codes at present but the studies being done as mentioned are a frontier area not only in India but Internationally. People were not clued to this matter since a lot non-linear analysis techniques and methods are involved which the common structural engineer does not interphase with them. However, that was necessary to arrive at the life cycle resilience of an asset. Hence the consulting fraternity needs to wake up to that.

Dr. Subbarao informed that there would be four speakers would make short presentations on various issues and he requested Mr. Rajat Taimni to dwell on a part of the legal issues of a Contract.

Mr. Rajat Taimni, Partner and Head of Practice-Dispute Resolution, Tuli and Co. Advocates & Solicitors, while speaking on the issue of ***"Evaluating Legal Risks in Contracts"*** drew attention to the need for Proper drafting of Termination Clauses. He queried "Is intention to provide termination for material breaches only which can be cured within a specified period upon giving notice?". If that be the case then what is the position when there is a fundamental or irremediable repudiatory breach of contract. Indian law recognises that ordinary common law remedies for termination on these grounds are available and if not then addressed properly in the Termination clauses these can have unintended consequences.

He then talked about "How are repudiatory breaches dealt with in termination clause?" and what are some of the ways in which the termination clause can be drafted to ensure contract certainty. Summing up Mr. Taimni said the "Legal Risks can be managed with robust consideration of issues and proper language which makes bargain between the parties clear and streamlines operation of the clause".

Dr. Subbarao thanked Mr. Taimni, for the short talk on some important legal aspects of a contract – the Termination Clause, which Engineers tend to overlook the Legal Risks. The next speaker Dr. Nikil Pujari was invited to inform about Catastrophe Modelling.

Dr. Nikil N Pujari, Senior Analyst, Model Research & Evaluation, Willis Towers Watson, WTW Global Delivery and Solutions India Private Limited presented the perspective of ***"Catastrophe Modelling and Industrial Outlook".*** He explained Catastrophe Models and as to why they are needed. A Catastrophe Model is a computer simulated model wherein models are made for national catastrophes like earthquake, hurricanes, floods and wildfire with the sole intention of revenue i.e., what primum one should pay, if there is a catastrophe. He went on to say that Catastrophe models are necessary for Life Safety, Risk Mitigation, Structural Safety, Understanding the underlying science of the hazard and vulnerability of a property, and Capital Protection. Thus, one need not pay for the full value of a property but only the premium when covered under the ambit of Insurance Policy.

The origin of Catastrophe Modelling as per documented evidence was sometime in 1880s when insurance was being sold for fire and lightning. Later on, research in

the 1970s led to hazard compilation and loss studies and gradually into the catastrophe industry. Later in 1987-88 it led to the first commercial model for catastrophe by AIR Worldwide, RMS and in 1994 by EQECAT. With the advent of commercial models there was the first open-source model by FEMA – the HAZUS Earthquake Model in 1992.

Talking of the Anatomy of a Catastrophe Model he explained that it involves five elements - the Hazard (Geophysical), Vulnerability (Engineering damageability), Exposure (Property Details - its value), Loss (Financial components) and Platform (Data Management). He moved on to the first module i.e., the Hazard Module which involves generation of Stochastic Events (the simulation of historic events) and Hazard Event Assessment where specific GMPE (Ground Motion Prediction Equations) are used to validate the hazard.

He showed the seismic vulnerability map of India based on IS 1893-2016 and also discussed the Bhuj earthquake event of 2001 and then the correlation table between Intensity (on MMI scale), Peak Ground Velocity (PGV), Peak Ground Acceleration (PGA), Damage and Shaking which helps to explain to clients seeking insurance.

With regards to the Vulnerability Module, he said that Vulnerability is defined as "the damageability of insurable coverages with respect to the loss numbers in terms of money" and explained Damageability, which defined as the Mean Damage Ratio of the Loss in terms of money of insurable coverage to the Total Cost of Coverage (Exposure) with reference to a graph. The four main parameters for designing vulnerability are Occupancy Type, Construction Type, Number of Floors, and the Year Built. He showed a chart giving a comparison of the Vulnerability Curves for different construction materials.

Explaining Risk Quantification and EP curves, Dr. Pujari explained that a convolution is done of the Seismic Hazard and Seismic Vulnerability to yield the Exceedance Probability Curve or the Risk Curve which plot the Loss vs Mean Exceedance Frequency (Return Period). He then presented a table of the Risk Quantification in the Catastrophe Industry showing Model A and Model B, for 3 different Locations in the Region/State and the AAL (Annual Average Loss) i.e., the Premium that has to be Paid and the loss for different Return Periods of the event for Residential and Commercial Properties. The Specialist provides the reasons for the figures and compiles the figures to show to Clients to understand the Risk Appetite for their insuring locations and what the different models convey.

While concluding Dr. Pujari, showed three references which those interested in understanding the subject could go through.

Dr. Subbarao thanked Dr. Pujari for talking about Catastrophe Modelling and how one goes about putting numbers and costs to a Risk and the numbers and premiums thereof; the different models and how to determine the actual numbers for the premium. Thereafter Dr. Subbarao called upon Mr. Abhishek Pal to tell about the Indian Standards relating to Hazards & Risks in Civil Engineering.

Mr. Abhishek Pal, Scientist 'C', Civil Engineering Department, Bureau of Indian Standards highlighted the ***"Indian Standards relating to Hazards & Risks in Civil Engineering".*** He presented exhaustive lists of the standards published for Construction Project Management; Safety Codes for New Construction, Addition/ Alteration and Demolition; Safety Guidelines; Safety Codes relating to all phases of Construction – Excavation, Foundation/ Substructure and Super Structure; Standards relating to Enabling Works and Other Safety Codes; and Safety Equipment/ Signs, Selection, Maintenance and Care of Safety Equipment and Occupational Health & Safety.

He moved on to list the major Standards relating to Structural Safety and the ongoing projects. He informed that BIS is also considering codes for Risk Assessment

and Structural Health Monitoring. He then talked about the Standards relating to Earthquake Engineering and the large number of ongoing projects - codes for Tsunami Resistant Design of Structures; Earthquake Resistant Design of Dams & Embankments; Probabilistic Seismic Hazard Map of India; Seismic Design of Pipelines; Performance Based Design; Seismic Base Isolation & Energy Absorption Devices; Seismic Microzonation Guidelines; Seismic Assessment and Retrofit of Masonry Buildings; Seismic Design and Ductile Detailing of Steel Buildings; Liquefaction potential of soils during earthquakes; Seismic Qualification of Equipment; Seismic Design and Damage Assessment of Structural Elements (Communication Towers, Non-Structural Elements, Bridges, and Water Tanks); Response Spectra (for 6 seconds and more) & Soil classification; and Post Earthquake Damage Assessment of Buildings.

He also dealt with the Standards published relating to Landslide Control/ Hill Area Development and the ongoing project on Preparation of Landslide Risk Assessment Maps in Mountainous Terrains, Geogrids & Soil nailing; Cyclone Resistant Structures.

He informed that IS:456, IS: 800 and IS:801 would also be revised

The comprehensive lists were shown are also available on BIS website.

Dr. Subbarao said that Mr. Pal had presented an exhaustive list of the codes which have been issued and those under preparation for hazards such as earthquakes, landslides, cyclones, tsunamis, etc. and dealing with them for safe design or management to mitigate risk for the built asset. Thereafter Dr. Subbarao invited Mr. Pranav Patel to talk on Risk and Insurance.

Mr. Pranav Patel, Senior Vice President, Marsh India Insurance Brokers Private Limited in a brief presentation covered the main issues of ***"Project Risks & Insurance"***. He said the Project Risks could arise on account of various issues such as: "Political, Regulatory/Legal, Economic, Currency/ForEx (availability, convertibility, repatriation and exchange rate), Off-take, Supply/ Feedstock, Construction, Operation, Technical, Employee/ Union, and Security". He then identified the Main Parties to a Project in General as being "Owner, Contractors and Sub contractors, Lender, Designer", and the "Contractor can further be sub divided into – Labour, Original Equipment Manufacturer, and Material Supplier".

He clarified that 'The Cost of Risk' is a part of the cost of a service/ product process and thus adds on to determine the Selling Price.

Moving on he said that for Identification of Risks, the Two Phases of Concern were Construction and Operations. During Construction they are "Completion Risk (Time), Engineering Risk (Safety) and Force Majeure (Act of God)" whereas during Operational stage they are "Supply, Market, Operations, Environmental, Infrastructure, Force Majeure, Political, Legal, and Forex/ Interest Rate."

Mr. Patel thereafter explained the Project Risks based on Project Phases: "Design & Fabrication, Transit, Erection & Storage, and Testing & Commissioning."

To mitigate the Risks a Comprehensive Insurance Coverage could be provided to cover "Transport, Storage, Construction/ Erection, Testing
Maintenance, and Operation."

At the end he said that the Primary Causes were "Faulty Design, Faulty Execution, Faulty Material/ Faulty Execution, Negligence, Faulty Material, Natural Event, Organisational deficiencies and Wrong Input Data".

Dr. Harshavardhan Subbarao, thanked Mr. Pranav Patel for enlightening everyone on risks and insurance albeit briefly. He then thanked all the speakers and panellist for the "excellent presentations and it was a pleasure to moderate the session today, I think they have put across a number of views and issues for consultants, owners and other stakeholders involved with projects

and organisations to deal with hazards and risks. To come up with various issues through this debate, which was our goal and we have achieved that quite well today". With that he invited Mr. A P Mull to give the closing remarks.

Mr. A P Mull, Past President CEAI said that "it has been an excellent session that we had today and must thank all the speakers and panellists for being with us, specially starting with Dr. N Krishnamurthy who gave a very good general overview, that it starts right from your doorstep, rather inside your house itself. Hazards & Risks are not something which are alien to any one of us.

There were people who talked of the legal aspects, there were two of them, Mr. Uttam Sengupta as well as Mr. Rajat Taimni, and we will be having more of these gentlemen sometime in September 2021, so look forward to that.

We had engineering aspects from Dr. Vasant Matsagar as well as Dr. Nikil Pujari and how they relate to insurance. That was a very good combination they did and ofcourse Mr. Pranav Patel zeroed in on the insurance aspect and how they all can fit into the bill.

We must also thank Mr. Abhishek Pal for listing out all the codes which can be readily accessed by anybody on the CEAI website and also the BIS website, they have given the references. If there are still any questions that need to be answered they can be referred to BIS, directly to Mr. Abhishek Pal.

I must thank Dr. Subbarao for moderating this event wonderfully. Unfortunately, our President, Dr. Pradhan had to go away for a Minister meeting and left the job of thanking everyone to me. I once again thank everyone and we will draw this session to a close."

CEAI is thankful to the supporters - Centre for Workplace Safety and Health, Mysuru, Tuli & Co. and the Structural Engineering Form of India (SEFI), the esteemed Speakers and Panellist who shared their knowledge, experience and expertise on the topic of Hazards & Risks; our Media partners Management & Communication Group, and Constrofacilitator and the most important - the participants for their patient hearing and raising questions in the Q&A and Chat boxes.

Link https://youtu.be/romt9Zkb1Ig

NEW VICE PRESIDENT OF CEAI

Mr Vishwas Jain, Chairperson of CEAI Northern Region and Managing Director of Consulting Engineers Group Ltd., Jaipur has been nominated as the new Vice President of CEAI for the term 2021-22.

MEMBER NEWS

Dr Ajay Pradhan inducted as Member of the Board of Management of KISS

Dr. Ajay Pradhan, President CEAI has been inducted as a Member of the Board of Management of Kalinga Institute of Social Sciences (KISS) Deemed to be University, Bhubaneswar, the largest residential tribal institute and the only university in the world exclusively for the tribal community.

Agreement between CEAI and Taylor & Francis for Technical Books

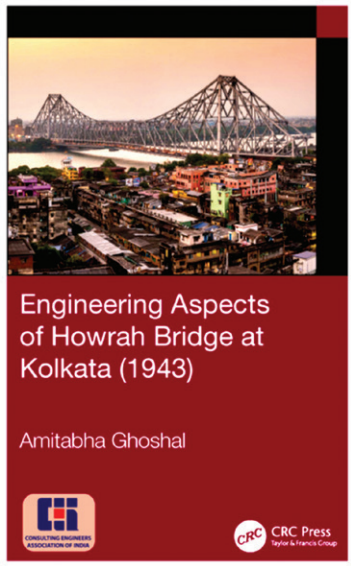
A kick start to fulfilling the spirit of an Agreement signed in December 2018 between CEAI and Taylor & Francis (T&F) was given by the launch of a book "Engineering Aspects of Howrah Bridge at Kolkata (1943)" painstakingly written by Mr. Amitabha Ghoshal, STUP Consultants Pvt. Ltd., Kolkata, India and the Immediate Past President of the Consulting Engineers Association of India. He spent a long time digging out the records at Braithwaite, Burn & Jessop, Kolkata to collate the material for the book.

It's pertinent to note that according to the Agreement CEAI would recommend to T&F prospective Authors from amongst its Members; T&F would review and decide at its sole discretion whether to publish any work; the work would only include technical books, professional books, monographs, textbooks, short form and handbooks of interest to a scientific audience; enter into a separate 'Author Agreement', may acknowledge CEAI by featuring CEAI's logo, brand and/or trade mark subject to the terms of 'Author Agreement', etc. The printing of the CEAI logo on the book projects the technical capability and experience of the Members and CEAI as an association per se.

Members are requested to pen down their experience for the benefit of sharing and educating the younger and future engineers. Needless to say, that it be best to first discuss the matter of an intended publication with CEAI and T&F.

Engineering Aspects of Howrah Bridge at Kolkata (1943)

Amitabha Ghoshal, STUP Consultants Pvt. Ltd., Kolkata, India



This is the first book that has seen the light of day as a result of an agreement entered into between CEAI and CRC Press to write technical monographs and books.

By penning the details of a famous bridge which has a lot of movie location glamour associated with it, Mr. Ghoshal has put his over 60 years of professional experience of dreaming, designing, detailing, constructing and erecting bridges to excellent use for the benefit of the engineering fraternity.

Howrah Bridge is an iconic engineering structure of Kolkata and is in excellent condition after 78 years of extensive use. This book covers all the engineering aspects of the structure explaining planning, design of super-structures, sub-structures and foundations along with fabrication and erection with a separate section on special features. Aimed at civil and bridge engineering students and graduate engineers, professionals, practising structural engineers as also heritage structure

enthusiasts this book covers detailed case study and a thorough description of a well-known and iconic bridge.
May 2021: 5.5 x 8.5: 102pp
47 illustrations
Hb: 978-0-367-54474-4 | £44.99
eBook: 978-1-003-08943-8

TABLE OF CONTENTS:

1. Introduction 2. Planning of the Final Option 3. Preparation of Tender Document 4. Design of Superstructure 5. Design of Foundations 6. Construction of Foundations 7. Steel Work – Supply & Fabrication 8. Erection of Steelwork 9. An Epilogue

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Best Overseas Paper Award to Mr. Amitabha Ghoshal

The Institution of Civil Engineers (ICE), UK, announced the best overseas paper award to Mr. Amitabha Ghoshal, Member of the Governing Council and the Immediate Past President of CEAI in their publication Engineering History and Heritage for the paper titled "Howrah Bridge: Icon of a 330 year old city in India – Part I, History, Planning and Design" by Mr. Amitabha Ghoshal.

A Solution to Reduce the Medical Oxygen Crisis

TATA Consulting Engineers Limited (TCE) in collaboration with the Indian Institute of Technology, Bombay (IITB) and Spantech Engineers have announced that they have successfully carried out a pilot plant study to covert nitrogen generation plants into ones for oxygen by replacing the molecular filters in the unit and few other minor refinements. This development would help address the current oxygen crisis for medical emergencies that have occurred on account of the pandemic.

With nitrogen plants in use at a large number of industrial units all over the country it would be a fast and easily doable solution that would ease the situation, since just about 3-4 days are required to convert an existing nitrogen plant to one for generating oxygen as against setting up a new plant which takes over 45 days. Besides it would cost about 10-15% of setting up a new oxygen plant.

Indian Institute of Technology, Bombay has validated the proof of the concept; now the technology needs to be scaled up. An MoU was signed between IITB, TCE and Spantech Engineers to finalise a Standard Operating Procedure (SOP) to scale up the technology.

Mr. Amit Sharma, Managing Director, TCE said that the technology is proven and has been in use since the 1970s. For more details please refer to the link below.

https://www.tce.co.in/wp-content/uploads/2021/04/Emergency-Oxygen-IIT-Bombay-TCE-Spantech-v1.pdf.

TCE - Engineering for Life and CSR Activities

Engineering for Life - Specific Engineering Solutions for COVID19

As the Pandemic's impact was being felt from March 2020 onwards, and while the teams were working on rewiring Tata Consulting Engineers' (TCE's) operations and taking other prudent measures, there was a deep sense of responsibility to the fight against the Pandemic. TCE's key currency is the intellectual prowess, thought leadership and innovative mindset

of its talent. The company took a firm resolve to use that currency and contribute effectively to the cause. To date, close to 15,000+ consulting person-hours have been devoted to fighting the Pandemic. TCE's efforts focused on ideating, conceptualising, designing, engineering, and enabling various innovative initiatives as a Pro-Bono activity.

The ongoing pandemic second wave required urgent actions towards enhancing the country's healthcare, medical oxygen generation, and distribution capacity. TCE's teams have made humble efforts towards contributing their bit on this critical requirement, focusing on Agility, Indigenisation aligned to Self-reliance, Quality and Cost Competitiveness. The company's actions have leveraged collaboration, teamwork, and partnerships externally to achieve more together in the shortest possible time.

1. **Emergency COVID-19 Infrastructure**: Teams from TCE and its subsidiary Ecofirst worked on war footing to conceptualise and design both modular units for COVID-19 patients and emergency jumbo COVID-19 hospital structures. The team collaborated with the Group Companies and multiple External Firms to provide these concepts and solutions for implementation and actual rollout.
2. **Oxygen Ventilators**: An engineering, feasibility and viability study was conducted on multiple ventilators, and a viable opensource ventilator was identified. The learnings were shared with group entities for evaluation, and appropriate next steps were suggested for mass manufacturing related tie-ups.
3. **Oxygen Distribution Supply Chain**: To enable last-mile oxygen distribution and supply chain logistics, TCE researched and presented the concept of conversion of cylinders such as CO2, CNG, LPG (for gas), etc. Suitable precautions, colour coding and planning for Gaseous Oxygen distribution across the country leveraging the existing LPG bottling and distribution network was also detailed and shared with the Petroleum and Explosives Safety Organisation (PESO)
4. **Oxygen Generation PSA Plant Scale**: To leverage the existing infrastructure in the country, the concept of conversion of PSA Nitrogen plant to PSA Oxygen plants was developed by TCE and successfully piloted along with the Indian Institute of Technology Bombay. Close to 75+ PSA Nitrogen plants (more expected to add up to 100+) are currently being converted for Oxygen generation.
5. **Oxygen Plant Critical Raw Material**: Jointly as a team, Tata Consulting Engineers, Tata Chemicals and the Indian Institute of Technology Bombay were able to garner support from the Government of India (GOI) for emergency airlift Zeolite from Germany with the support from BASF leadership. The implementation of the concept is being done with the help of the Ministry of Environment entity Central Pollution Control Board (CPCB) as assigned by the GOI with the project managed by TCE.
6. **Oxygen Generation using O2 Concentrator**: TCE prototyped opensource design (www.oxikit.com) in less than five (5) working days with benchmark results of 10-20 LPM with 90-94% oxygen concentration. TCE made necessary design changes and process refinements to ensure benchmark results under Indian conditions. Except for the Zeolite, locally available Indian parts for the prototype were used. The Opensource oxygen concentrator design is actively being explored by startups, entrepreneurs and MSME's across India.
7. **Oxygen Infrastructure within Hospitals**: TCE teams are assisting various Central Government efforts, State Governments, Startups, NGOs and Hospitals on all of the above matters and are also providing consultancy for new PSA Oxygen plants, hospital oxygen infrastructure, pipelines and related checklists and audits. TCE has responded to more than 3000+ requests for information and support in the past three weeks since mid May 2021.

8. **Project O2 for India**: TCE is proud to be a part of the 'Project O2 for India' initiated to ensure the supply of critical raw materials such as zeolites, the setting up of small oxygen plants, and manufacturing of compressors. The consortium is not only looking forward to providing immediate to short-term relief but is also working to strengthen the manufacturing ecosystem for long-term preparedness.

For more details, please visit https://www.tce.co.in/tce-combating-covid/

Corporate Social Responsibility during Emergency COVID-19

At Tata Consulting Engineers, we are committed to ensuring the social wellbeing of our people, communities we live and operate in and the country at large. Education, Healthcare, Sustainable livelihood, Infrastructure Development and Scientific Research are some of our focus areas. In FY 2020-21, TCE employees clocked 5027 volunteering hours across 96 CSR programs and our CSR activities impacted over 8450 lives. TCE works with the Indian Institute of Technology- Bombay and the Indian Institute of Science on cutting-edge sustainability related research projects.

Health & Hygiene

In Health and Hygiene, TCE, along with its NGO partner, works with underprivileged communities in far-flung villages and conducts various health camps and awareness sessions. Covid-19 Kits comprising essentials were distributed among these communities, and the treatment plan for Covid-19 positive patients in home quarantine was managed in a timely and effective way. Covid-19 related testing camps, testing and treatment camps for other ailments, surgeries like cataract, etc., were also conducted. Over 1300 villagers have benefited from this program to date. TCE's NGO partner also helps skill medical health workers and run a special program for them.

Education

TCE partners with an NGO to educate the marginalised, nomadic and migrant communities, including children of construction workers and migrants. To date, over 1500 children have benefitted from TCE's education program. During the Covid-19 pandemic, TCE's NGO partners helped conduct online classes, distribute self-learning tools through WhatsApp, videos, etc. and physical worksheets, and kept track of student learning. Numerous Covid-19 Awareness sessions were conducted, and distribution of Covid related necessities like masks, sanitisers, food and ration.

Sustainable Livelihood and Infrastructure

TCE with NGO partners works with tribal households in the field of sustainable livelihood. From training them to grow cash crops, crop diversification, collective marketing, to various other welfare programs are conducted. During the COVID-19 pandemic, the households were taught kitchen gardening and how to grow their crops to meet their nutrition requirements.

Food and ration were also distributed among these communities.

Disaster Relief

TCE is also providing Consultancy Services for school infrastructure being developed in Puri, Orissa, as part of Tata Community Initiatives Trust (TCIT). This Trust has commenced the reconstruction of school buildings damaged because of the super cyclone, Fani.

TRIBUTE TO Dr. DHAVAL M PARIKH

Dear Friends and Colleague

With heavy heart, I have to inform you all that Dr. Dhaval M Parikh, Vice President of CEAI & President International of Aarvee Associates Pvt. Ltd. passed away on 8th May 2021 with Covid related complications. Sorrow fills our hearts at this sad moment, a sorrow that is deep and personal.

Dr. Dhaval M Parikh gave much to his work, as an excellent professional and international collaborator. We offer our heartfelt condolences and keep his family in our prayers and thoughts. Dr. Parikh educated in India and USA with PhD Degrees in engineering. He was a brilliant business and contract manager, the only FIDIC accredited trainer in India. He was very sharp in articulating matters in a lucid manner.

I have known Dr. Dhaval M Parikh since 1999 when he was working with Sheladia Associates as Business Head, and I was working as the Development Director in DHV Consultants. We worked in joint ventures for several road projects along with Aarvee Associates and Sheladia. As such, he contributed much to the development of the Sheladia, SAI and then as International Head for Aarvee.

Dr. Parikh was deeply concerned with improving collaboration with FIDIC headquarters and he was very keen to impart training at different levels to government organisations.

Dr. Parikh was a good boss to the people in his charge, a loving husband to his wife, and a devoted father to his children. He was also a good friend to many of us and a great colleague.

In his career as Head of Business Development in Sheladia, President of SAI and the last position that he held as President International for AARVEE, he worked with passion, integrity and energy. By his passing away all the people who knew him will miss a highly intelligent, vibrant individual with a rare friendliness and charm of personality. Dr. Parikh was a genuinely warm and wonderful individual - one we will miss greatly. Our sorrow is lessened only slightly with the comforting thought that we had the privilege to know him.

We pray to the Almighty to rest his soul in peace. Om Shanti!!!

Dr. Ajay Pradhan
President -CEAI

FIDIC NEWS

ENGINEERS NEED TO BE AT TOP TABLE TO INFLUENCE CLIMATE CHANGE DEBATE

15 Jun 2021

Source: FIDIC News https://fidic.org/node/33205

Construction professionals from around the globe gathered at a webinar on 15th June 2021 to discuss the key role of the infrastructure industry in achieving a net zero world at the latest event in FIDIC's ongoing committee webinar series, writes FIDIC communications advisor Andy Walker.

The latest webinar in the series, "The role of the infrastructure industry in achieving a net zero world", was attended by 534 people and highlighted the pivotal role of the construction and infrastructure sector in the fight against climate change. The webinar, organised by the FIDIC Sustainable Development Committee, underlined the international nature of the race to net zero and the importance of a coordinated campaign to address sustainable development worldwide.

The webinar was moderated by Tracey Ryan, Managing Director of Aurecon, New Zealand and chair of the FIDIC Sustainable Development Committee. Panellists included Bernard Aritua, Senior Infrastructure and Logistics specialist at The World Bank in China, Lara Young, Group Carbon Manager at Costain in the UK, Adrienne Miller, General Manager New Zealand at the Infrastructure Sustainability Council, Vijay Kulkarni, partner at Midas Techfin Consultants in India and Natalie Muir, General Manager, Water and Environment, for Cardno and Vice Chair of the FIDIC Sustainable Development Committee from Australia. They were joined at the event by FIDIC President Bill Howard and Chief Executive Dr Nelson Ogunshakin.

Kicking off the webinar, Tracey Ryan, Managing Director of Aurecon New Zealand and Chair of the FIDIC Sustainable Development Committee, said that climate change remained the most urgent challenge facing the world, notwithstanding the ongoing experience of the Covid pandemic. "Decarbonisation will require the best thinking from all of our industry sectors and it's clear that without international action to combat climate change, the campaign to address its effects will be all the more difficult," said Ryan.

First speaker, Adrienne Miller, General Manager New Zealand at the Infrastructure Sustainability Council, said that there were big changes taking place across the world on sustainability issues, the pace of change was increasing and that this was in turn increasing the risks involved for those working in the sector. "In New Zealand there seems to be an increasing public will to address the country's net zero targets and the infrastructure industry will have an important role in mitigating climate change risks. But that means that there are real opportunities for the sector too," Miller said.

Vijay Kulkarni, partner at Midas Techfin Consultants, offered a perspective from India on the fight against climate change. He said that the construction industry needed to take a lead and not only rely on the government's measures. "On solar energy we need to persuade people that this is the way to go. The costs of solar and wind have reduced by one third and are more attractive options and consultants in particular can get this message across," he said. Kulkarni also made the point that it was important to secure reductions in energy use and also carbon emissions. "We need to involve all stakeholders in this and FIDIC can help in this area too," Kulkarni said.

Lara Young, Group Carbon Manager at Costain in the UK, said that it was crucial to retain a constant focus on driving down emissions. There was no "silver bullet" to solving the problem of climate change but it was important to achieve clarity on where the greatest opportunities were in the lifecycle of a project to reduce emissions, Young said. "It's important to really focus on the greatest emission sources at the outset," she said as that was the best way to achieving success. Breaking things down into "bite-sized pieces" was the approach that Costain had taken to the climate change and this was paying dividends, said Young.

Bernard Aritua, Senior Infrastructure and Logistics specialist at The World Bank in China, said that it was "great to be around engineers" as they offered a different perspective on global challenges. Aritua addressed the issue of where the finance would come from to 'build back better' post Covid and highlighted the role of The World Bank in promoting investment in sustainable infrastructure through its 'green bonds'. The bank has had to look at how it deals with the shift towards green investment and there has been a big paradigm shift from "doing no harm" with investment towards "doing good". "It's not enough to receive funding from the World Bank for a project you have to show how this investment will benefit communities," he said.

Aritua also spoke about the role of engineers in promoting the effectiveness of what they do. Engineers were rarely featured in decision-making bodies, yet they had a key role, a crucial role, in addressing the climate challenge. "Engineers need to position themselves better to influence the debate on this issue," said Aritua.

Natalie Muir, General Manager, Water and Environment for Cardno and Vice Chair of the FIDIC Sustainable Development Committee from Australia, highlighted some of the work of this crucial FIDIC committee in addressing climate change, including the development of a 'Climate Pledge' that would offer the industry valuable guidance in the sustainability arena. Muir also spoke about the committee's work in supporting the FIDIC State of the World reports, many of which had a key focus on sustainability. "Policy is important but at the end of the day it will be the engineering and scientific community that will make net zero happen," Muir said. She urged the industry to "reimagine infrastructure" to rethink solutions and to think holistically. "It is crucial that our sector is involved at all early stage in the process and we need that opportunity to contribute so that we can drive the world towards net zero," said Muir.

The panellists' contributions sparked many questions and discussion from attendees at the webinar. These covered a range of issues including whole life costs, contractual issues, the sustainability challenge for developing countries whose need for heavy infrastructure is greater, the skills gap in the industry hampering the campaign for net zero, the effects of Covid on sustainable development, making construction materials greener and why is it the case that engineers are not sitting at the top table for discussions on climate change.

The role of the engineer and the need to have their input at the top table when decisions on addressing climate change and achieving net zero were being made was repeatedly highlighted during the webinar. "Why did lawyers and economists get to run the world and how can engineers take a more prominent role in decision making? Do engineers need to get more active in politics?" summed up the tone of many attendees posting questions during the event.

Attendees also highlighted the point that the impacts of climate change were human issues and it was important not to lose sight of that. As Adrienne Miller said: "All the economic analysis in the world is going to be utterly useless if we don't have a world to live in." Miller's comments were echoed by Vijay Kulkarni, who said that "no section of society could be left behind" in the fight against climate change.

Summing up the webinar, panellists highlighted that "the time for sustainable big picture thinking was now", that "green procurement policy" was essential to achieving net zero, especially in the public sector, that "people needed to take ownership of the agenda and we don't need to wait", the industry needs to "adapt, innovate and inspire" and take ownership of transforming the world and that the construction sector "needed to be at that top table in building a better world".

The next FIDIC webinar is entitled, "The post-Covid consulting engineering industry – Future Leaders' global perspectives", which takes place on Tuesday 29 June 2021 at 12 noon CET. Please register your place as soon as possible to secure your place at this free event.

Click here to book your free place at the FIDIC webinar, "The post-Covid consulting engineering industry – Future Leaders' global perspectives".

Watch the recording of the webinar, "The role of the infrastructure industry in achieving a net zero world" on the link below.

https://youtu.be/3XroikGucmI

OTHER NEWS, VIEWS & NOTES

VIEW POINT

The theme for the September 2021 issue of CEAI's quarterly magazine *VIEWPOINT* is ***"Flood Management in Built Environment".***

The Built-Environment is expanding by leaps and bounds. While it helps to improve the quality of urban life it is also disturbing the environment, especially the water bodies, lakes, rivers, and coasts. Professionals are invited to discuss how the two apparently opposing needs of urban expansion and reduction of water bodies, waterways, river regime, lake shores and sea coasts could be managed so as to obviate flooding in urban and even semi-urban areas. Glacial movement issues affect the semi-urban areas in the mountains and if not addressed can create disasters.

Professionals involved with urban development and the environment are invited to give their views and share their thoughts plus share their experiences, ideas and innovative solutions so that humans can utilize scarce resources and still maintain the balance with Nature.

Professionals are urged to share their knowledge and experience by providing case studies of the works executed or in execution, first-hand accounts of the challenges faced, practical issues experienced and the solutions to those, etc. Photographs, charts, diagrams, drawings, etc. would benefit readers for better appreciation of the issues encountered and the manner in which they were addressed.

The themes for the balance issues of *VIEWPOINT* for 2021 and 2022 are given below.

Sl. No.	Theme	ViewPoint issue
1	Flood Management in Built Environment Guest Editor: Mr. Dilip G Sonwane, AVP Built Environment, Infrastructure Business, TCE	September 2021
2	Changing Technologies for Consulting Engineering (to cover Business as well as Technical matters) Guest Editor: Mr. Atul Choudhari, Deputy CTO, TCE	December 2021
3	Becoming *Atmanirbhar* – Concept to Reality Guest Editor: Mr. Pradeep Chaturvedi, Chairman, Interdisciplinary Coordination Committee, IEI	March 2022
4	Contract Management	June 2022
5	Tall Buildings in India (to cover all aspects conceptualisation to end of design life)	September 2022
6	Technology/ Engineering for Sustainability and Circular Economy	December 2022

The articles for an issue need to reach CEAI at least 6 weeks prior to the end of the month of the *VIEWPOINT* issue. Articles need to be in Times New Roman 12, single line spacing with before and after 6 pt and justified paragraph layout with normal margin on A4 size in single column format. A recent clear and bright passport size photograph of the author (in jpg format) is to be sent along with the article..

Advertisement in View Point

VIEW POINT is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public & Private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign Missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession.

Advertising in the VIEW POINT gives the advertiser wide exposure and visibility.

Support from CEAI members and stakeholders are sought in increasing the number of advertisements, such that View Point gain in its stature as a unique Technical Publication.

The rates for advertisements in VIEWPOINT are given below. This is excluding GST @ 5% or as prescribed, which will be extra:

Item	Rate Per issue* (Rs)	Discounted rate at 20% for 4 consecutive issues* (Rs)
Back Cover**	25,000/-	80,000/-
Inside Front Cover ***	15,000/-	48,000/-
Inside Back Cover ***	15,000/-	48,000/-
Full Page	10,000/-	32,000/-

*GST @ 5% or as prescribed will be added to the above rates.
** Back Cover booked till March 2022
***Inside Front & Back Covers booked till June 2022 & Sept 21, respectively

Thermal power plants performance set to improve; Excess capacity could decline over FY22-FY24

The research agency also expects a pick-up in PLF of plants which are placed lower in the merit order

New Delhi: The operating performance of thermal power plants could improve meaningfully, given the change in the incremental demand supply equation after a decade, according to research agency India Ratings (Ind-Ra).

This lowering of supply is because of the limited capacity addition of thermal power plants, the retirals or phasing out of old capacities largely from the state sector and the slowdown in renewable capacity addition, it said.

“The demand side is likely to remain robust on account of a pickup in industrial activity, early signs of capex revivals, given the strong balance sheet position of corporate India, and pick-up in exports,” the firm said in a statement.

https://energy.economictimes.indiatimes.com/news/power/thermal-power-plants-performance-set-to-improve-excess-capacity-could-decline-over-fy22-fy24/83562123

Tech Quiz

1. Who first introduced the concept of risk?
   a) Fermat
   b) Graunt
   c) Kautilya
   d) Dante
   e) Pingala

2. Around when did modern risk management originate?
   a) After WW I
   b) After the Plague
   c) After Great Depression
   d) After WW II
   e) After the Spanish Flu

3. When was the first to use the word 'resilience' in English?
   a) Francis Bacon
   b) Lucian Freud
   c) Roy de Maistre
   d) John Deakin
   e) Henry Hobart

4. In which field was concept of resilience first introduced?
   a) Social
   b) Ecomics
   c) Agriculture
   d) Medicine
   e) Engineering

5. Who is the founder of statistical economics?
   a) Petty
   b) Vishalaksha
   c) Kautilya
   d) Pascal
   e) Graunt

6. Who introduced the concept of resilience to Ecosystems?
   a) C S Holling
   b) Plutarch
   c) S Giedion
   d) Plato
   e) L H Gunderson

7. When was the Building Back Better (BBB) document adopted by the UN General Assembly?
   a) 2018
   b) 1995
   c) 2015
   d) 1999
   e) 2010

8. Which organization introduced the first risk management department in a bank?
   a) Deutsche Bank AG
   b) Industrial & Commercial Bank of China Limited
   c) Standard Chartered
   d) Merrill-Lynch
   e) Citibank

9. What type of risks should be considered during project risk analysis by an engineering company?
   a) Risks related to the location of the project.
   b) Reputation risks.
   c) Contractual risks
   d) Financial risks.
   e) All of the above.

10. According to Maylor, what are traditionally the core three risk categories?
    a) Cost, Schedule, Quality
    b) Environment, Cost, Legal
    c) Resources, Schedule, Health and safety
    d) Cost, Profitability, Cashflow
    e) Safety, Profitability, Ethics

The first person who mails the correct answers to CEAI ***info@ceai.org.in*** will get a congratulatory mail and will be acknowledged by publishing the persons photograph in the next issue.

Contributed by A P Mull and Ramesh Ramakrishnan, General Manager, Tata Consulting Engineers Ltd.

Answers to Tech Quiz March 2021 issue
1(b), 2(d), 3(c), 4(d), 5(a), 6(d), 7(a), 8(b), 9(d), 10(e)

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- Over 60 Airport Projects Involving Planning, Design & Supervision
- Road Safety Audit/ Black Spots Improvement/ Awareness Campaigns in over 100 Assignments
- Water Supply Schemes for over 500 Towns and Villages
- Design of over 4,100 Bridges, Tunnels and other Structures
- Over 45 Projects of Railways and Metro Rails
- Master Plan and Development Plans for over 77 Cities/Towns
- Irrigation Planning & Design of over 8,00,000 ha. Gross Command Area

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Tunnels

Airports and Aviation Systems

Railways and Metro Rails

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Institutional Development and Capacity Building

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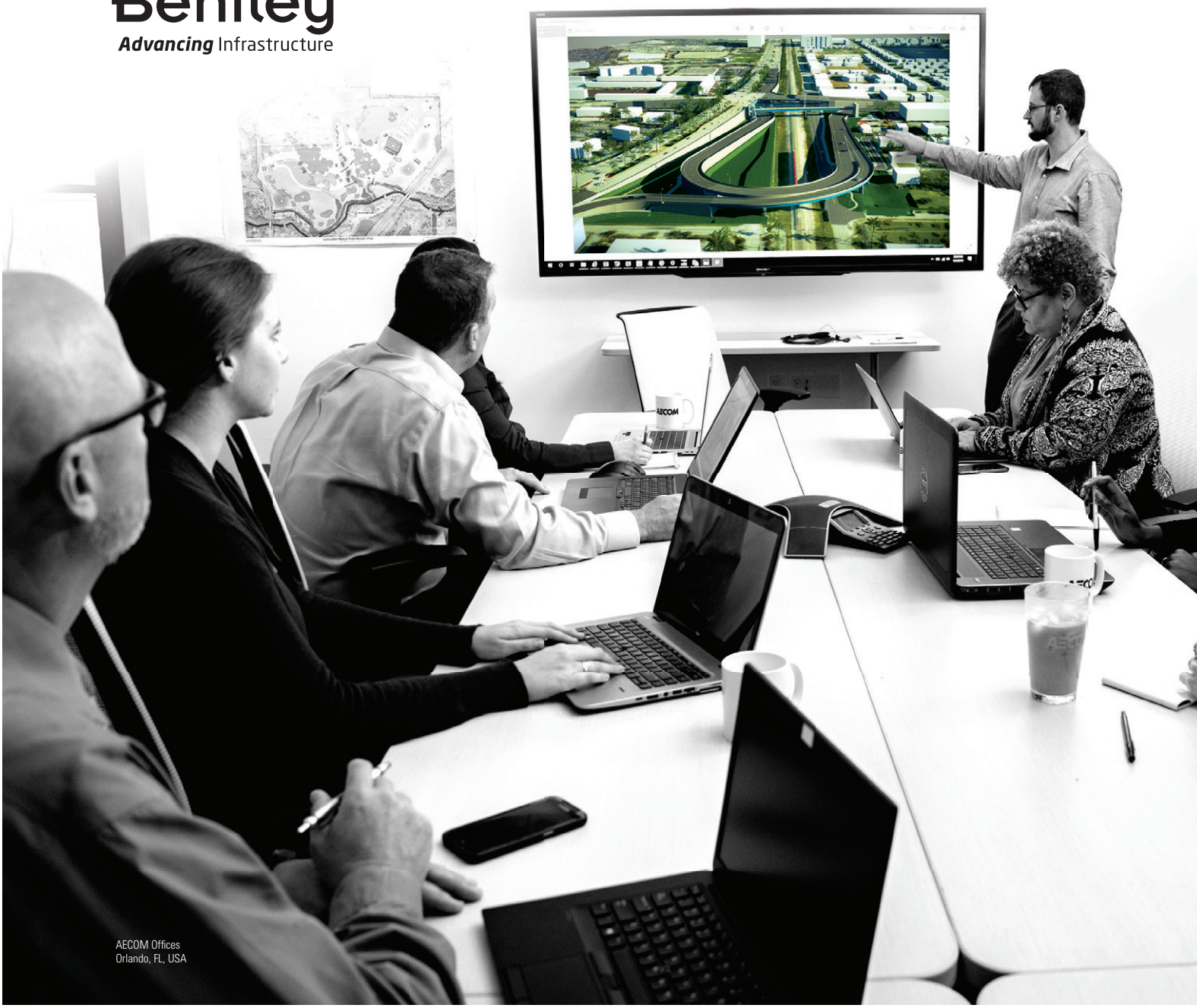

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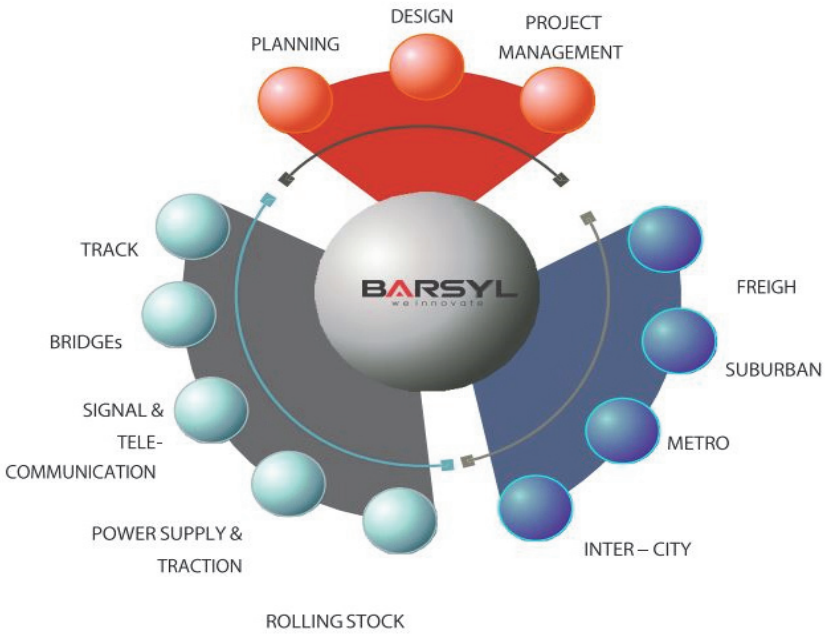

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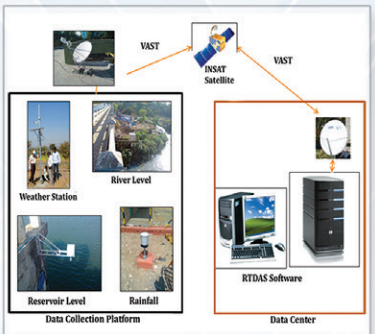
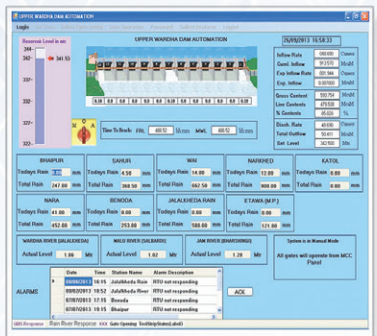
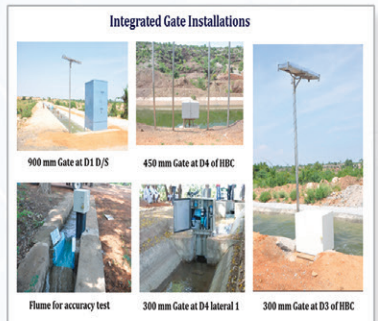


Real Time Hydro Metrological Information System(RTDAS)



Flood Forecasting & Flood Management System with Dam Automation



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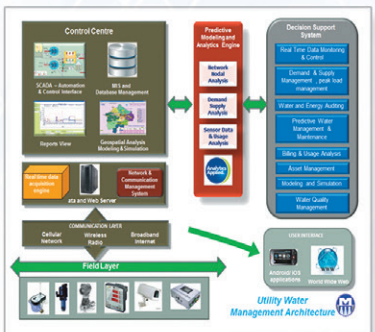
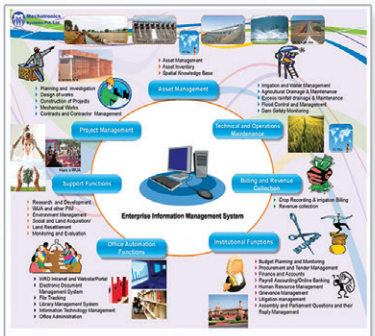
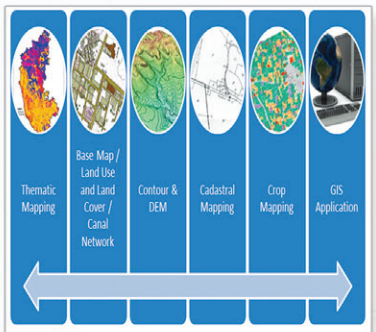


Smart City water Supply Management



Enterprise Management Information System



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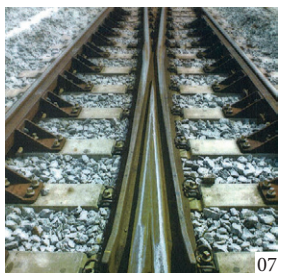
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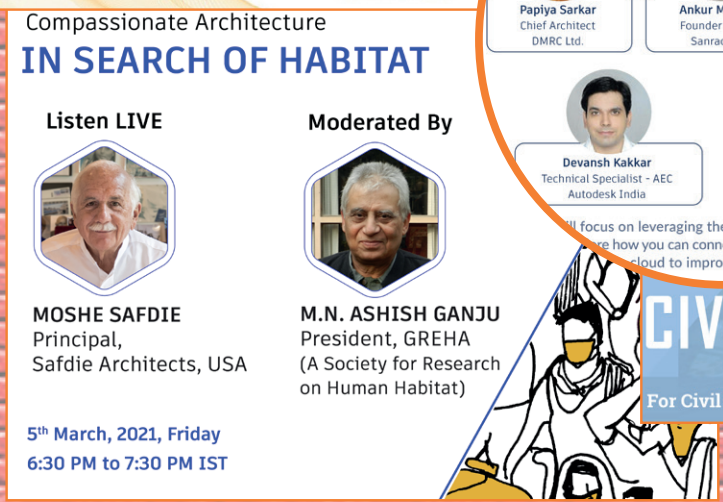

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