Engineering Council of India

19th National Conference

on the theme

Role of Engineers in Accelerating Economic Growth

&

21st Foundation Day

Eminent Engineers' Award Function

April 28, 2023 (Friday)

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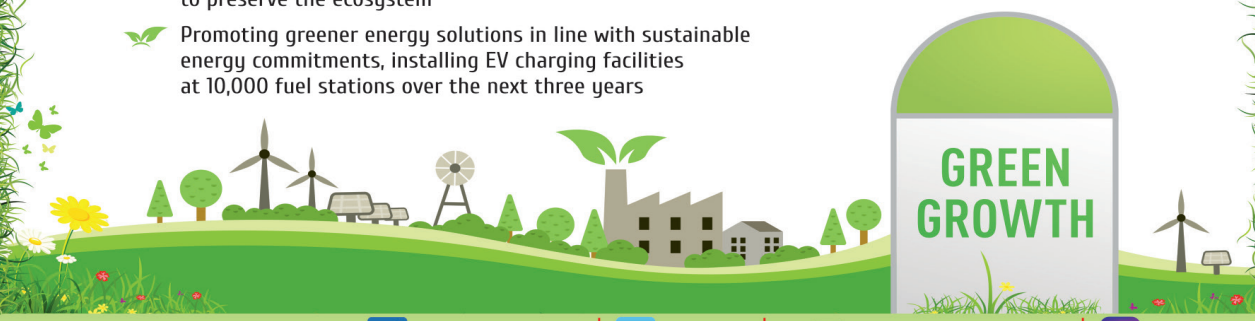

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Registration in ECI's National Register of Professional Engineers

Engineering Council of India(ECI) was established in 2002 as the apex body of the engineering profession in India. Today it has 33 Indian Professional Engineering Associations/ Institutions (MAs) representing all major streams of engineering in India. It is mandated to work for the advancement of engineering profession in all disciplines and for enhancing the image of engineers in society, by focusing on quality and accountability of engineers and to enable the recognition of expertise of Indian engineers and their mobility at international level in the emerging WTO/GATS environment. It has emerged as a common voice of its member organizations.

ECI has initiated the Registration of Professional Engineers, Associate Professional Engineers, Apprentice Engineers, Junior Apprentice Engineers and Student Engineers, jointly with the Member Associations on a voluntary basis, since November, 2015.

There are separate National Registers for (i) Professional Engineer (P.E), (ii) Associate Professional Engineer (APE), (iii) Apprentice Engineers (Ap.E), (iv) Junior Apprentice Engineers (JAp.E), (v) Student Engineer (SE). These registrations are for a period of maximum 5 years. During this period the registered engineers have to continuously keep upgrading their skills and knowledge in association with the respective MAs. At the end of 5 years the status would be reviewed. The Registers are uploaded on ECI's website and they can be used for checking the status of the registered engineer.

1. **Criteria for registering as Professional Engineer (PE)**: The candidate

i. Has a Bachelors' Degree in Engineering / Technology from a recognized university / institution or equivalent qualification as approved by the All India Technical Education / Government of India.

ii. Has relevant working experience of at least 7 years as an engineer, of which at least 2 years is in a responsible position of significant engineering activity.

iii. Is of good character (has not been involved in any case of moral turpitude).

iv. Is evaluated through a written examination or interview, to be conducted by the Engineering Council of India or its Member Associations.

v. Has maintained continued professional development since graduation at a satisfactory level.

vi. Undertakes to adhere to the Code of Ethics laid down by ECI.

vii. Makes a formal application with prescribed fee to the ECI.

Exemptions on Experience for PE

i. The candidate can be credited with 2 years of experience if he/she has a postgraduate engineering degree from a recognized institution.

ii. The candidate can be credited with 3 years of experience if he/she has obtained a Ph.D. from a recognized institution.

iii. Maximum exemption for higher education shall not exceed 3 years.

Exemption of Examination/Interview:

For those having a total of 20 years of experience, of which at least 10 years is in responsible position- (Grandfather's clause). Those having 30 years' experience and admitted under this clause can be designated as Senior PEs.

Criteria for registering as Associate Professional Engineer (APE) –

As for P.E. above, with experience reduced to 4 years. APE can register as PE after 7 years of experience, of which at least 2 years is in a responsible position of significant engineering activity, without any further examination/interview.

Criteria for registering as Apprentice Engineer (Ap.E) –

As for P.E. above, with experience up to 4 years. Ap.E can register as APE after 4 years of relevant experience, without any further examination/ interview.

Criteria for registering as Junior Apprentice Engineer (JAp.E)-

As for P.E. above, but with an Engineering Diploma instead of an Engineering Graduate degree, and with experience up to 5 years. JAp.E can register as Ap.E after 5 years of relevant experience, without any further examination/interview.

Special Provision for holders of Diploma or B. Voc. degree in Engineering Subjects:

They can be registered as PE or APE, if they hold or have held the position as Assistant Engineer or above in Construction/Projects/Plants, with 5 years' additional experience over and above that specified for Engineering Degree holders.

Criteria for registering as Student Engineer (SE)-

Enrolled as a student in Bachelors' Degree or Diploma in Engineering / Technology in a recognized university / institution or equivalent qualification as approved by the All India Technical Education / Government of India. The SE can enroll as Ap.E/ JAp.E after graduation, after undergoing an examination/interview.

For more details kindly visit www.ecindia.org.

Role of Engineers in Accelerating Indian Economy and thus achieving Sustainable Development and Economic Growth

- Prof. Jawahar Lal Narayan

Hony. Treasurer and former Executive Director, Engineering Council of India

Synopsis

Engineers can play an important role in accelerating Indian economy. This paper underlines as to What are the roles of engineers in infrastructure, and economic development? Engineers build infrastructure and therefore facilitate economic development. Without a healthy number of engineers, a country cannot implement ambitious development plans that focus on technological advancement.

The paper gives a snapshot of the Indian Economy in the past few years, identifies ambit of Engineers role playing in accelerating Indian economy and ultimately achieving the status of a developed economy. The also addresses the challenging scenarios of national and international development

Introduction

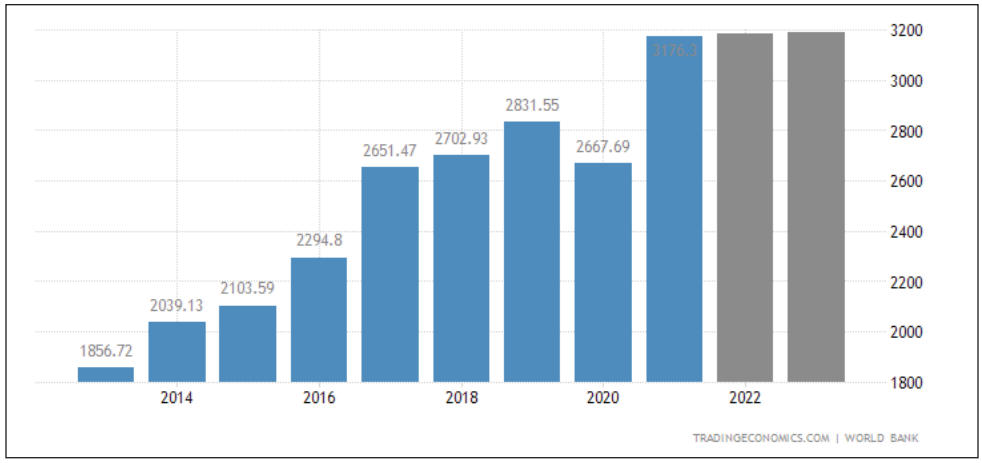
The India's achievement of SDGs over the last -7 years is really laudable, the government has been ensuring that people at the "bottom of the pyramid" get the benefits that are due to them, the benefits flow to them through the trinity of government initiatives - Jan Dhan bank account, Aadhaar unique identity number and mobile phone. The financial inclusion through 310 million accounts, 120 million gas stoves provided, the sanitation drive which built nearly 60 million of toilets across the country and the Ayushman yojana to cover health needs of the poor. According to 2019 global Multidimensional Poverty Index (MPI) of UNDP, India lifted 271 million people out of poverty between 2006 and 2016. India's health coverage has also helped reduce poverty and improve livelihood. That number alone is mind-boggling and it speaks to the success of targeted interventions at a level and scale of ambition that is without parallel in any other country in the world.

The result has been that, today, India is the fastest growing, 5th largest economy in the world. It grew about 7 per cent during fiscal year 2021-22. Growth has brought increased volume of revenues, which have permitted the Government to sustain a high-level of social spending that directly targets poverty.

Role of Engineers is seen everywhere in the world. Indian Engineers have made India, an "epicentre" of innovative solutions in handling COVID effectively both frugal innovations and the most advanced technological and digital-based solutions. The country is also the epicentre for addressing globally the most pressing needs of the world particularly in harnessing green energy with international partnerships. India is not shying away from that responsibility and is bearing that responsibility with great sense of seriousness and understanding of the implications for the world. India as President of the G20 making great strides in bring the whole world at the common platform.

1. India 's Growth Profile

India/Gross domestic product (Billion US $): Source IMF



Related	Last	Previous	Unit	Reference
GDP Growth Rate	0.69	1.70	percent	Dec 2022
GDP Annual Growth Rate	4.40	6.30	percent	Dec 2022
GDP	3176.30	2667.69	USD Billion	Dec 2021
GDP per Capita	1936.94	1796.49	USD	Dec 2021
GDP per Capita PPP	6592.04	6114.03	USD	Dec 2021
Full Year GDP Growth (Rs)	7.00	9.10	percent	Mar 2023

The gross domestic product (GDP) measures of national income and output for a given country's economy. The gross domestic product (GDP) is equal to the total expenditures for all final goods and services produced within the country in a stipulated period of time.

Actual	Previous	Highest	Lowest	Dates	Unit	Frequency	
3176.30	2667.69	3176.30	37.03	1960 - 2021	USD Billion	Yearly	Current USD

In FY22/23, India's real GDP expanded at an estimated 7 percent. Growth was underpinned by robust domestic demand, strong investment activity bolstered by the government's push for investment in infrastructure, and buoyant private consumption, particularly among higher income earners.

1.1 During 2020-20, In spite the Impact of COVID, Indian economy made extraordinary effort not only to Combat COVID but made innovations in transforming Indian economy by harnessing technology to achieve higher economic growth, made policies and fiscal and monetary incentives to enhance role of tiny enterprises, startups, and MSMEs. This helped India towards self-reliant. With increased manufacturing in defence production, India could achieve the status of a defence product exporter. Also, India could meet majority of its defence needs with quality defence production in partnership with the private sector.

1.2 We can see and talk about the most exciting technologies and projects we have completed in the recent years. But behind every one of these innovations, you'll find dedicated engineers working day and night to help develop the physical infrastructure we all rely on – transport networks, roads, bridges, water and energy supplies, and waste management. We also have them to thank for our digital infrastructure – communications and navigation networks that are part and parcel of urban life. Engineers play a huge role in healthcare and food, and in manufacturing and research.

1.3 And by building this infrastructure, engineering has had a much wider and more lasting impact – it has helped to fuel economic growth. well-built housing and sanitation improves the quality of life of all residents. Good transport links with high speed dedicated corridors, and trains make it easier for businesses to trade their goods, and enables the workforce to be more mobile. high-speed internet boosted productivity, improved efficiencies, and helped organization to look beyond its local or national borders….. the list is endless.

2. Role of Engineers in sustainable development

2.1 India's aspiration to achieve high income status comparable to the developed countries by 2047 will need to be realized through a growth process that delivers broad based gains to the bottom half of the population. Growth-oriented reforms will need to be accompanied by an expansion in good jobs that keeps pace with the number of labour market entrants. At the same time, gaps in economic participation will need to be addressed, including by bringing more women into the workforce.

2.2 India is partnering with the World bank in this effort by helping strengthen policies, institutions, and investments to create a better future for the country and its people through green, resilient, and inclusive development.

2.3 What is the role of an engineer in sustainable development? Engineers have played and continue to play a key role in the future of sustainable development. Whether it is building new products or working on technologies that will innovate the future, they are instrumental in designing, architecting, and building the way products, goods and services are delivered and consumed. To boost the nation's Sustainable Development Goals (SDGs), engineers remain key contributors in the vast chain of modern production and consumption of natural resources to deliver goods, products, and solutions for the larger society.

2.4 Today, it is crucial for organizations to invest in co-innovation and collaboration, and work towards a world with reduced carbon footprint. India is taking a lead position in harnessing green energy in partnership with whole world. Engineers must focus on incorporating sustainability by design across business and operations, and significantly, research and development to enable sustainability in product solutions. How can engineers build sustainable products? While many aspects need to be factored in, a key ingredient to drive sustainable change is – innovation. For instance, organizations building products for the automobile industry are innovating differently from those designing modern applications to ensure services can be delivered online by digitizing the same. For successful sustainable strategies, organizations

must harness emerging technologies (like AI, ML, blockchain, etc.) to gather and ascertain valuable insights to build products that have a lasting positive social and environmental impact along with cost savings and business value. The way forward is for companies to support, encourage, and grow mindsets that allow the engineering community to incorporate sustainability in every solution, product, or service, redefining what it means to be a force for good. We, engineers in India, should be committed to accelerating a more equitable, sustainable, and resilient digital future. We recognize that all aspects of our business have an impact on our environmental footprint—from the products we create to the people we employ. Our 2030 agenda reinforces our commitment to de-carbonizing our operations, supply chain, and digital infrastructure across our customer ecosystem.

3. Perceived Role of Engineers in Accelerating Indian Economy

3.1 Engineering Index

According to Centre for Economics and Business Research (CEBR), relative strength of each country is measured by Engineering Index which is measured by combining factors such as the number of engineering businesses, the quality of existing infrastructure, investments and exports of engineering goods and services, as well as research quality, gender balance, wages and employment figures. Using that ranking method, Sweden came out on top, followed closely by Denmark and the Netherlands. The UK currently ranks 14th, with the U.S. in 17th and China in 22nd. India and Vietnam appear in 46th and 38th position on the index, respectively. But unprecedented growth in their urban populations, along with strong economic performances in recent years have earmarked both as "future hotspots" for engineering.

This directly indicates India's weeness in achieving quality and optimum engineering products and services. This a matter of great concern for our competitiveness. The Engineering council of India, in collaboration with its Member Associations and Affiliate Members should work on this aspect as to how India could improve its Engineering Index. To my mind we can focus on:

- Harnessing new technology, AI, Block chain etc.
- Develop Engineering quality in all Sectors,
- Strengthen Professional Skill Development of engineers/ technocrats and scientists in addition to skill development suitable for the industry in the current environment. Government has given high priority to this area.
- Recognition of skilled engineers as Professional Engineers through their registration with ECI and other similar bodies.
- Partnership and Collaboration should be designed and negotiated in such so that India's engineering quality and capacity is improved at a faster pace

4. Quality of Institutions

The other important aspect for engineers to address is the number of quality engineering/ technical / scientific institutions in the country. The present Government has taken steps to increase the number of quality institutions. In addition, Government has brought new

Education Policy to combat language and reginal barriers in providing quality education in India.

4.1 An important aspect to mention here is the brain drain, lot of our engineers/ technocrats/ scientists from our premier institutions join international companies in leading positions. This has happened due to low paying capacity of Indian industries/ institutions. Of late, there is a good sign, foreign engineers of Indian origin are taking up startups in India and at the same time foreign companies moving their manufacturing hubs in India.

4.2 Engineering Council of India and its Members should continuously strengthen the government's hands with its relevant analysis and feedback.

5. Regulation of Engineering Profession

The profession of Engineering is similar to that of accounting, medicine, law, architecture and so forth, as it requires a high degree of integrity and accountability. Therefore, to strengthen the effectiveness of the engineering profession, they need to be regulated, with an appropriate Code of Conduct. Why regulate? We view the profession of engineering, plays an important role in the building of an economy such as India. Developments, whether they are infrastructure, private, or public cannot take place without proper input from professional engineers. It is for this reason that the profession of engineering must be regulated.

- For Legislative Efficiency- to have a comprehensive, consistent statutory registration system for engineers that would alleviate inconsistencies across jurisdictions.
- For Professional Recognition- so that the set of standards and skills expected of the engineers are maintained.
- And finally for the Industry/consumer efficiency- to provide consumers with the level of experience and skills that is required of the engineer.

Efforts were made by Engineering Council of India to get an Engineers Act, for which a draft Bill was submitted to the government, but so far it has not taken place. This needs to be considered and acted upon by the government as soon as possible. Presently, the regulation through registration as Professional Engineers with Engineering Council of India, together with adherence to a code of conduct can provide regulation on a voluntary basis. In fact, in some countries (such as UK), the regulation of engineering profession is done by professional bodies on a voluntary basis, and not by statutory bodies.

The profession of engineering plays an important role in the building of an economy such as India. Developments, whether they are infrastructure, private, or public based, cannot take place without proper input from professional engineers. It is for this reason that the profession of engineering must be strengthened and regulated.

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The IMF and World Bank Reports.

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Skill Development and Employability in Constructon Sector: Prerequisites of Atmanirbhar Bharat

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Abstract

The Honourable Prime Minister, Narendra Modi coined the term, 'Atmanirbhar Bharat' to change the strategic narrative of India from survival to strength. This is to focus on generation of more employment in the current scenario which will further accelerate the demand for a skilled workforce. India's skilled workforce is nearly four percent (Only four in every 100 workers are skilled). The construction industry is also not unaffected by this trend. Despite a significant 19 percent contribution in the Gross Domestic Product (equivalent to USD 3000 billion) in 2011-12, the fragmented nature of the industry and lack of industry academia collaboration has led to the I proliferation of unskilled workforce in the sector. The advantage of India is that country is expected to become the third largest construction market globally by 2022 and it has a requirement of investment worth Rs 50 trillion (US$ 777.73 billion) across infrastructure by 2022 for a sustainable development in the country.

Key words: Atmanirbhar B housing sector

1. Introduction

The structural reforms required for Atmanirbhar Bharat can only be accomplished when skill development becomes the mainstay of this ambitious plan launched by the Honourable Prime Minister. Skilling, up skilling and re skilling of youth, who are the workforce of the nation, will play a crucial role in the successful realisation of the government's vision. According to a survey conducted by the NSSO , there is a lack of training facilities in India in 20 high growth industries such as logistics, healthcare, construction, hospitality and automobiles.

The construction industry is the second largest industry in India after agriculture, accounting for 8 percent of India's Gross Domestic Product. Indian construction industry employs 32 million people and its total market size is estimated at Rs. 2,48,000 crores. It accounts for about 65 percent of the total investment in the infrastructure development and is expected to be the foremost sector to witness unceasing growth in the coming years. Although in last couple of years this sector has shown some downward trends because of global factors like economic recession, and internal procedural factors like acquisition of land etc.[1], India's construction sector is expected to grow well above the overall growth of the Indian economy as a whole. A recent study by Global Construction Perspectives and Oxford Economics has

1 While its growth rate in 2010-11 was 8.0 per cent, in 2011-12 it decelerated to 4.8 per cent. However in 2012-13 it has again reached 6 per cent in 2012-13.

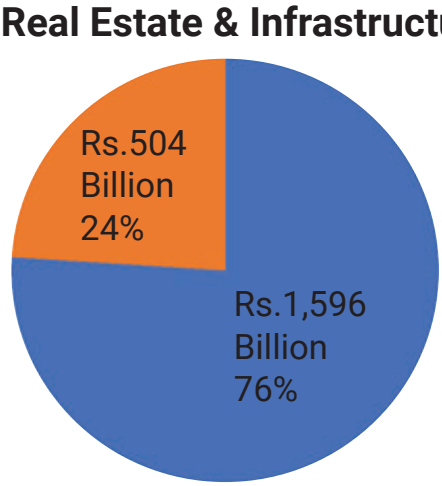
argued that India will become the world's third largest construction market by year 2025 and will have a market of $ 1 trillion market.[2]

Construction industry has two primary segments – 1) real estate which includes residentialbuildings,industrialconstruction like factories, IT parks, commercial construction like shopping malls, hotels etc. and, 2) infrastructure which includes roads and highways, bridges, flyovers, airports, urban infrastructure etc. The Real Estate segment contributes around 24% to the Construction GDP of India while Infrastructure segment contributes around 76%. The Indian real estate sector attracted $5 billion institutional investments in 2020. By 2020, construction equipment industry's revenue is estimated to reach $5 bn and 100% FDI, under automatic route is permitted in completing projects for operations and 100% FDI is also allowed under the automatic route for urban infrastructure such as urban transport, water supply and sewerage and sewage treatment.

The construction industry in value terms is expected to record a CAGR of 15.7% to reach $738.5 bn by 2022. It is observed that by 2025, construction market in India is expected to emerge as the third largest globally and by 2025, construction output is expected to grow on average by 7.1% each year[3]. In Union Budget 2020-21, the Government has tried to give a massive push to the infrastructure sector by allocating Rs 1,69,637 crore (US$ 24.27 billion) to enhance the transport infrastructure.

Private sector is emerging as a key player across various infrastructure segments, ranging from roads and communications to power and airports. Private investment into physical and social infrastructure is key to putting India in a high growth trajectory, which will make it a US$ 5 trillion economy by 2024- 25. FDI in construction development sector (townships, housing, built up infrastructure and construction development projects) and construction (infrastructure) activities stood at US$ 25.66 billion and US$ 16.84 billion, respectively, between April 2000 and March 2020[4]. The advantage of India is that it is expected to become the third largest construction market globally by 2022 and it has a requirement of investment worth Rs 50 trillion (US$ 777.73 billion) across infrastructure by 2022 for a sustainable development in the country[5].

Figure 1: Share of Real Estate and Infrastructure by GDP contribution



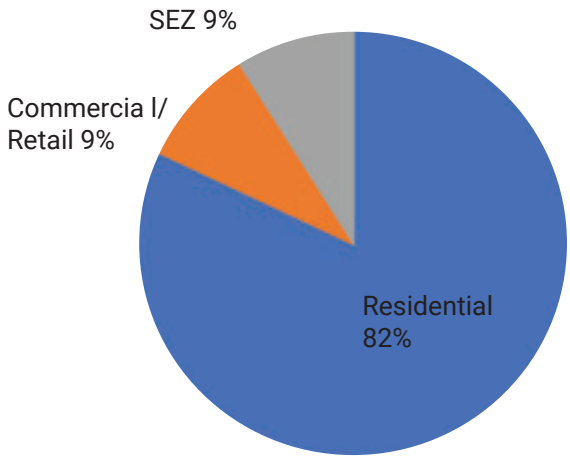
Source: Economic Survey 2007-08, IMaCS analysis

2 Economic Times, 1 July 2013 http://economictimes.indiatimes.com/india -to-be-worlds-3rd-largest-construction-mkt -by-2025/articleshow/20856489.cms
3 Consolidated FDI Policy Circular of 2020, Government of ndia, Ministry of Commerce and Industry Department for Promotion of ndustry and nternal Trade FDI Division)
4 India Brand Equity Foundation (IBEF) June 2020), www.ibeforg retrieved on 14.05.2021
5 India Brand Equity Foundation (IDEF) June 2020), www.ibeforg retrieved on 14.05.2021

2. Real Estate Sector

In terms of GDP contribution, Real Estate sector is estimated at around Rs. 504 billion in 2007- 08. The market size of the Indian real estate sector is estimated to be around Rs. 2,643 billion in 2007-08. This sector has been growing at a CAGR of 12%. It is constituted of the Residential, Commercial and real estate activities of Special Economic Zones.

Figure 2: Real Estate Segment

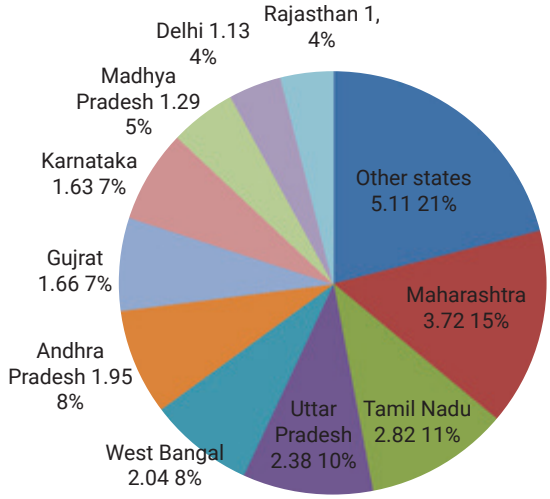


Source: Research Ministry of Commerce and Industry, IMaCS analysis

3. Housing Sector

At around Rs. 2,171 billion, the housing sector is estimated to grow at 12% in the long term. Demand for housing was estimated to be around 4.8 million houses per year over the Eleventh Five Year Plan period. In addition to the need for new housing tenements, the demand is also likely to be fuelled by the housing shortages already prevalent in several states. The shortage of housing across several states, as illustrated in the graph below, amounts to about 25 million houses in the period of the Eleventh Five Year Plan.

Figure 3: Housing Shortage by State over of the Eleventh Five Year Plan (million houses (% of Share of Various states)



Source: Planning Commission Working Group on Urban Housing, 2007

3.1 Demand drivers for Housing Sector

i. Favourable Demographics The demographics work strongly in favour of the Indian Construction Industry. India is the second highest populated country in the world after China. IQJI'\ approximate population as of 2019 is 1.36 billion, while the average age of Indians is about 26.8 years. The demographic profile indicates V Q1I'\ ZRTJsiQJ SRSOIlt}RQ TRTP \ flhlROQlflIL of the total population. India is and will remain one of the youngest countries in the world which leads ~R Ii\eTIQ P 103l3IRD\\ \e3P eQtW 7 EE\ \e3P eQt'\ increasing purchasing power and propensity to consume is expected to push and support a robust growth rate of the economy in the coming years. The middle class along with robust macro-economic scenario and changing demographic profiles has a pivotal role to play in the emergence and growth of the Construction Industry in India.

ii. Urbanization and Migration The decadal

growth rate of urban population (20% between 1991- 2001) in India is higher than the rural population (18% during the same period). Average annual rate of change (AARC) of the total population in India during 2000-2005 was estimated at 1.41% with 2.81% for urban and 0.82% for rural sectors. AARC for Urban areas by 2025 will increase to 2.25% whereas the AARC for rural population will decline to -0.4% showing a clear shift of population from rural to urban areas. The average household size has been estimated by the NSSO as being around 4.47 in urban areas and only 67% of the houses are pucca units. Though there is a slump in the real estate activity over the last one year, investment over the long term will be primary led by housing, which is expected to account for nearly 90% of the total real estate sector.

4. Detrimental Skills Gap

On the path to becoming an economic superpower, India significantly lags behind its global counterparts in terms of the skilled workforce. As per the estimates of Confederation of Real Estate Developers Association of India (CREDAI), India's skilled workforce is nearly four percent (Only four in every 100 workers are skilled), while countries like Germany (74 percent skilled workforce), Japan (80 percent skilled workforce), and South Korea (96 percent skilled workforce) are way ahead of India. The construction industry has been severely affected by this trend as well. Despite a 19 percent contribution in the Gross Domestic Product (equivalent to USD 3000 billion) in 2011-12, the fragmented nature of the industry and lack of industry-academia collaboration has led to the proliferation of unskilled workforce in the sector.

4.1 Reasons for Skills Gap

The prime reasons behind the unskilled workforce in the construction sector are

i. Lack of industry-academia collaboration- There is a vast disconnect between the curriculum being taught in academic institutions and the ground level real requirements of the industry. Jointly developed curriculum and mentorship from the industry will bridge this gap and improve the situation.

ii. Poor remuneration- In comparison to the soft areas like IT and banking, the construction industry offers poor remunerations and lack of skills on the candidate's part worsen the scenario.

iii. Lack of skilling courses- There is a real shortage of technical courses for the construction industry. Industrial training Institutes must include the construction and allied industry related courses as a trade so that the students can learn the advanced skills before entering the job market.

However, all is not all that obscure and recent focus on skill development across India has led to increased awareness about the construction industry as a career option.

One of the major reasons of this sad predicament of construction industry is lack of fitting and temporality relevant systems of human resource development at work person's level, which constitutes around 87% of the total employed persons, or in terms of absolute numbers, close to

27 million citizens. This malaise extends to the upper strata of the professionals as well, however, the least privileged segment is also the largest portion of those engaged in construction activities.

This is due to the several social and institutional limitations, which are inherent in the very nature of this industry. These are:

i) Systematic erosion of conventional guilds.

ii) Lower economic strength of learners and even lower incentives to learn, due to lower wage structure applicable to the sector.

iii) Lack of interest on the part of employers to institute well-structured training programs.

iv) Absence of regulatory provisions to employ and often preferential wages to the trained & certified trade persons.

5. Mission Skilling India

The graphic below states the need for ramping up our capacities for undertaking skilling India on a massive scale. The current capacities in training HR in all sectors is woefully short and concerted efforts are required from all stakeholders to increase capacities.

Figure 4

Considering the demand for skilled workforce for construction, the industry and government aim to further strengthen the mechanism for providing training to unskilled workers who constitute bulk of the workforce. Various initiatives have been initiated at both pubic as well as private levels. National Skill Development Policy aims to train 53 Crores workers in all sectors by 2022, out of this, Construction Industry Development Council has been provided a target of training-cum¬certifying 20 Crores construction workers. With greater emphasis on physical infrastructure development and the robust demand for housing, the requirements for skilled manpower the construction sector is bound to increase manifold and sufficient opportunities for employment of trained manpower exist in the sector. Concerted efforts have to be further expanded in order to meet the workforce requirement of the sector.

The impetus on physical infrastructure development has led to the entire nation witnessing frenetic construction activities urban and rural infrastructure development, housing, transportation. High influx of skilled workforce is required to sustain these construction activities and skill development initiatives in this sector will definitely help in providing more captive workforce for these projects as well as provide viable alternate employment opportunities to the beneficiaries to get absorbed in a vibrant economic activity.

Present number of training institutions, their annual capacity of training and projected number of trained persons by 2022 for different Ministries/ Departments / Organizations is given in the table below. These targets are based on projected employment potential in the concerned

sectors. This may, however, needs to be reviewed from time to time according to growth of sectors and their actual workforce requirements.

Table 1

No	Ministry/Department/Organisation	Present number of institutions	Present training capacity per annum (IN LAKH)	Projected number of trained persons by 2022 (IN LAKH)
1	National Skill Development Corporation	--	--	1500
2	Labour & Employment	33,000	12 .00	1000
3	Tourism	38	0.17	50
4	Textiles	277	0.15	100
5	Transport	1	0.02	300
6	Tribal Affairs	63	0. 06	
7.	Rural Development (RUDSETI) and IL & FS	156	5.48	200
8.	Women & Child Welfare	68	17.50	100
9.	Agriculture	72	19.81	200
10.	HRD Higher Education HRD Vocational Education	10,000(Voc. schls)	19.60	500
	(Engg. Coll. 2297 Polytechnics 1675)	14.00		
12	Urban Development	34	0.013	150
13.	Department of Information Technology	1000 (Affiliated centres) + 7 CDAC	1.37	100
14	Food Processing Industries	34	0.10	50
15	**Construction Industry Development Council (under Planning Commission)**	**147**	**4.64**	**200**
16	Health & Family Welfare	3802	1.35	100
17	Micro Small Medium Enterprise	356	2.92	150
18	Social Justice & Empowerment	Through NGOs & others		50
19	Overseas Indian Affairs	In partnership with MSME/etc.	0.13	50
20	Finance-Insurance/Banking	*		100
21	Consumer Affairs	*		100
22	Chemicals & Fertilizers	6	0.19	50
23	Others (Power, Petroleum etc.)	NA		150
	Total		**99.46**	**5300**

Source: National Skill Development Policy, 2014

6. Government Initiatives

Government of India has taken several initiatives under the Skill India mission to promote the construction industry as a promising and well-paid career option. Some of the initiatives are -

i. **National Skill Development Council** - It was set up with a primary objective of catalysing the skills landscape of India. It aims to proactively create quality vocational training institutions and enhance the capability of existing ones. It partners with international

institutions, state governments, business houses, and industry at large for their active support to the cause of skill development in various trades.

ii. **Construction Industry Development Council**- Established by the Planning Commission (now NITI Aayog), Government of India and the Construction Industry is the pioneer of skill development in the Construction Industry in India. The Council, through its training centres and qualified and trained training staff, is imparting the several skill developments programs throughout India.

iii. **Construction Skill Development Council of India** – Registered as a nonprofit organisation under the National Skill Development Council (NSDC) through Public-Private Partnership (PPP) model, it is a one of its kind arrangements between the government and private sector to promote skill development in India. It helps in the active engagement of youth in skill development related to the construction sector, training the trainers, certification of trained workforce and alignment of their skills according to the National Skills Qualifications Framework (NSQF).

iv. **National Occupational Standards -** These standards are developed by the Construction Skill Development Council of India and are used by organisations to build curriculum and developing the training modules.

v. **Pradhan Mantri Kaushal Vikas Yojana (PMKVY)** - PMKVY is an outcome-based skill training programme of the Ministry of Skill Development. The objective of this scheme is to mobilise a large number of youths in taking up the outcome-based and industry-relevant courses and make them employable in the industry.

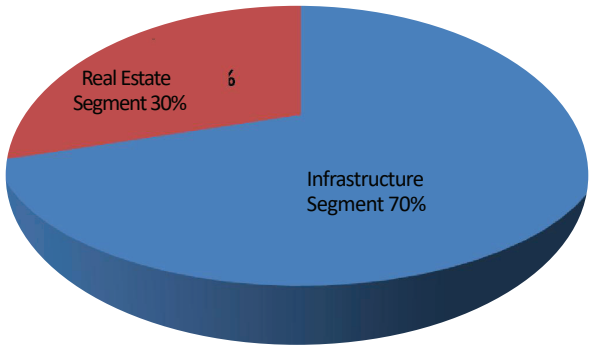
vi. **National Skills Qualifications Framework (NSQF)** - It is a competency-based framework which organises skills and qualifications according to the levels of knowledge. These levels, ranging from one to ten, are arranged in terms of learning outcomes, which the learner must possess. The learnings could have been obtained by formal or informal training. Under this, the learner can get a certification from NSQF.

vii. **Pravasi Kaushal Vikas Yojana (PKVY)** – Skill India mission aims to train the youth of India with skills relevant in the global market. To meet the demands of internationally relevant skills, India International Skills Centres are established by the government. These centres provide skills through PKVY so that youth aspiring to get a blue-collar job abroad (mostly in the Gulf region), can go with the required skills and certifications.

7. Manpower Profile and Requirements in the Construction Sector

The Building, Construction and Real Estate sector in India currently employs around 33 million persons. Around 30% of these are employed in the Real Estate segment, while the remaining 70% is employed in Infrastructure segment.

Figure 5: Breakup of employment in Building, construction and Real Estate sector in India



Source: Economic Survey 2007-08, CREDAI, Primary Research and IMaCS analysis

It was estimated by the Planning Commission that the Construction industry employed 31.46 million personnel in 2005.

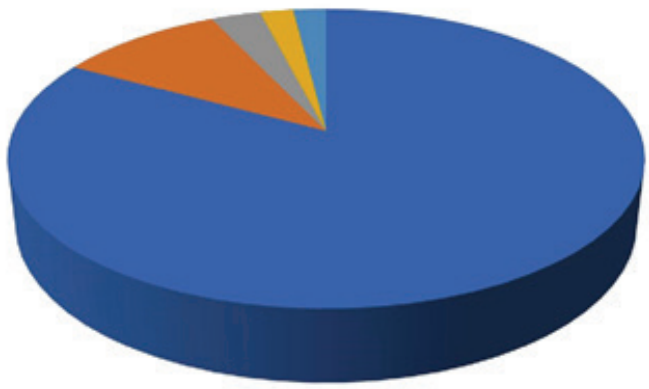
Table 2: Employment in Indian Construction Industry

Occupation	Numbers employed in 1995 (in 000's)	Numbers employed in 2005 (in 000's)
Engineers	687	822
Technicians and Foremen	359	573
Clerical	646	738
Skilled Workers	2241	3267

Source: Report of the Working Group on Construction for the 11th Five Year Plan, Planning Commission, Government of India

The bulk of the work force at around 82.5% constitutes unskilled workers, 10% constitutes the skilled workers and the rest is constituted by engineers, technicians, foremen and clerical staff.

Figure 6: Breakup of employment in Building, Construction and Real Estate sector India education wise



Source: Report of the Working Group on Construction for the 11th Five Year Plan, Planning Commission Government of India and IMaCS analysis

7.1 Functional distribution of human resource in Construction Industry

As seen in the table 3 below, a significant proportion of the workforce is involved in the core operations (i.e., at the construction site). Further, this proportion is similar across the Real Estate and Infrastructure segments. The following table presents the functional distribution of personnel employed by the project developer (it does not include construction workers, who form the largest portion of the workforce as shown later), as these persons are typically employed on a contract basis.

Table 3: Functional distribution of human resources in Building, Construction and Real Estate sector in India (persons employed directly by builder/developer)

Operations	Function	Distribution
	Project managers	2-3%
	Engineers/Supervisors	23-25%
	Foreman (shuttering, steel, concrete, finishing, etc)	8-10
	Account/Billing/Stores	7-8%
	Planning	1-2%
	Surveying	1-2%
	Quality/Lab	3-4%
	Safety	5-6%
	Support functions (mechanics, electrician, security, etc.)	9-10%
Projects (design, overall planning & scheduling, procurement, etc.)		15%
HR, Admin, Finance, Communications, IT		15%

Source: Primary Research and IMaCS analysis

The personnel employed in these functions and the amount of labor personnel required, will depend on the type of construction (high-rise/ low-rise building, industrial plant/ residential building, property footprint, etc).

7.2 Distribution of human resources by education level

The following table 4 represents the education-wise composition of construction personnel across various segments of the building, construction and real estate sector in India. As seen, most of the persons employed in this sector are those with minimal education.

Table 4 : Distribution of human resource by education level across the industry

Education Qualification	**Distribution**
Ph.D./ Research/ CA/ MBA/ etc.	1%
Engineering Degree	2%
Diploma or equivalent certificate by other agencies	2%
ITI and other vocational Courses	13%-14%
10th Standard or below	81%

Source: Primary Research and IMaCS analysis 7.3 Profile of people employed

7.3 Profile of people employed

The profile of the people employed in the Real Estate segment and Infrastructure segment at the field level, i.e., on the construction site is similar and the following table 5 illustrates this profile:

Table 5: Profile of people employed in the Housing Sector and Real Estate Sector

Qualification	Post in Housing Sector	Post in Real Estate Sector
Graduate engineers/ post graduate engineers (relevant field experience important)	Project Manager	Project Manager
Mainly graduate Civil engineers, some graduate mechanical engineers	Engineers	Engineers
Diploma engineers/ it is with experience	Supervisors	Supervisors
Mainly it is (can be own/ contractual employees)	Skilled Workmen	Skilled Workmen
Minimally educated (mainly contractual employees)	Unskilled Workmen	Unskilled Workmen

7.4 Manpower Requirements in Construction Industry

The Construction sector provides direct/indirect employment to about 41 million people and is expected to employ about 92 million persons by 2022 as described in Table 6. Thus almost 50 million additional jobs may be created in Construction in the next 10 years.

Table 6: Requirements of Human Resources for Construction (2022)

No	Category	Number
I	Engineers	3.72 million men years
II	Technicians	4.32 million men years
III	Support Staff	3.65 million men years
IV	Skilled Workers	23.35 million men years
V	Unskilled/ Semi skilled workers	56.96 million men years
Total Manpower Required		**92 million men years**

Source: XIIth Plan Approach Paper – Planning Commission 8. Conclusions

8. Conclusions

This paper establishes that there has been a crucial skill gap in the construction industry in India which has been detrimental to the growth of not only this specific sector but also the overall economy. In order to accomplish the visions of the Prime Minister towards building an Atmanirbhar Bharat which could position itself as a global superpower, it is pertinent to place special emphasis on skilling in construction industry considering its

premier position in the Indian economy. The current pandemic has posed a real challenge of job uncertainty and crisis particularly to the un-skilled and semi-skilled workforce. The need of hour for Atmanirbhar Bharat is to up skill the workforce. The government has already taken the much needed first step which needs to be augmented through a special attention and comprehensive strategy for up skilling of workforce in the Construction Sector which is the second largest employment sector and has enormous opportunities for employment.

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Future Ready Engineers for New challenges of Economic Growth

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Abstract:

The Industrial Revolution is on a roll, and the 4th Industrial Revolution (4IR) is now the global blurring boundaries of our physical -digital- and biological worlds. With the Fusion of advancements made in AI- artificial intelligence, IoT -the Internet of Things (IoT), robotics, 3D printing, Web3 -of immersing oneself in digital experiences, genetic engineering, quantum computing, blockchain and other technologies. Meeting the Sustainable Development Goals SDGs 2030 with a collective force behind the new demands and challenges in Environment, Sustainability and Governance. A perfect storm of technologies in the 4th IR sets a new way for transformative changes radically disrupting our present-day engineering education curricula. Built on the foundations of the first three industrial revolutions, society is set to change like never before, as there has never been a time of potential peril or a greater promise. But all these may also lead to job market disruptions that may become increasingly segregated into "high-skill/high-pay" roles and "low-skill/low-pay", with the possibility of escalating social tension.

With the likely introduction of Innovative materials -including biomaterials, plastics, and metal alloys, green steel all promises a shake-up in various sectors, including manufacturing, renewable energy, construction, and healthcare.

Energy capture, storage, and transmission represent a growing market sector spurred by the falling cost of renewable energy technologies and improvements in battery storage capacity.

All these require a realignment of the curricula at Government Institutions. The industry-run Engineering Institutions may keep on dynamic corrections.

Key Words: Future Ready Engineers, 4th IR, Skill-Pay Match.

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1. **Introduction:** New Education Policy in India has been rolled out with a lot of bureaucracy load that slowed down a long-perceived Policy. The new set of demands on society are SDG goals emphasising a) sustainability-one of the 17 SDGs, b) digitalisation-Technology and Science driven, and c) employability-future market-driven, requiring an increased base of innovation and entrepreneurship.

   Engineering education is market-driven and community-oriented modes within the universities.

   Engineers must be capable of co-creating sustainable development in line with SDGs so the Industry and society's needs are met, coupled with the Climate change-related compulsions on the societies. The digitalisation needs of future-ready Engineers are higher than before.

   The achieve the above, the curricula content and pedagogical methods

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need a review.

The pedagogical approach touches all the modes covering the academic mode emphasising on theoretical knowledge; the market-driven mode, with its focus on employability; and the community-driven mode, with its emphasis on civic society and sustainability.

2. Where Are We Heading-Future of Engineering and Technology?

The new limitations set by the ESG regime bring various sectors that involve Engineers getting impacted, to name a few, are.

Aerospace: defence: and security: Automotive : Construction: Consumer goods Banking and payments: Foodservice: Healthcare: Insurance: Mining: Oil and Gas Packaging: Power: Retail and apparel; Sports; Technology: media: telecoms and Travel and tourism.

2.1 To understand the convenient impact sample of the Power Sector is considered here.

The power Sector has been bridled with "moving targets of Reliability and Resilience". No power cuts, low voltage, or frequency changes were on the priority list of the engineers till recently to make the economy move smoothly, handling retrofits of ageing equipment, and no pollution was added on. SAIDI and SAIFI system-related average numbers, making reliability indexing at the uppermost mind of Power Sector Engineers. The work from home is shifting the power load centres to be handled by the engineers. Energy resilience, Energy storage systems, handling infirm power by renewables and Cyber-attacks are new challenges. with a capital-scarce environment, balancing the outcome preferences are important to be governed by the Engineers. [11.4]. The Facets of Power Systems and the skills of Power Engineers have changed a lot regarding Reliability and Resilience. [11.8] and optimising Resources for the Future. [11.7}

The SDG goals and the political compulsions add another challenge to the affordability of Power for all. Decarbonising Power Sector as a part of ESG has taken a top priority. These aspects need a proper place in Engineers' Curricula, if not at the University level but by the professional bodies holding knowledge-sharing seminars.

3. And where are we at present in Engineers Education?

The present education system is defined in 3 modes.

Mode 1 Academic Mode 2 Market-driven Orientation to Community: with educational curricula Contextual competencies Cultural awareness Sustainability Professional identity

Mode 2 Orientation to companies and instrumental practice with Learning: Situated learning Blended collaborative learning Student-centred Organization: Partnerships with NGOs North-South: south-south collaboration

Mode 1 + Mode 2 + Community orientation Mode 3 Hybrid Learning - An Integrative Approach Educational

content: Contextual competencies Cultural awareness Sustainability Professional identity Citizenship Learning: Situated learning Blended collaborative learning Student centred Organization: Partnerships with NGOs North-South collaboration Orientation to academia and theory.

Mechanical Engineering is the demand to meet the needs of Industrial Economies: Power and Energy Engineering is in high order. These two have been listed for this paper. Similar inferences can be drawn for other disciplines [11.2}.

4. Future Ready Engineering institutions: During a survey by the Royal Institute of Technology Stockholm, Sweden, it emerged that the Engineers of tomorrow must have a broader knowledge than deep specialisation in one subject like" T vs I."

5. Role of Government agencies: AICTE: Academia- A continuum study must be undertaken to beat the huge inertia built in our bureaucracy in India that requires a long time to move because of the large country size and diversified regional development.

6. Financial institutions: The investments are now focused on the ESG progress of any organisation or institution. The Financial Institutions will consider the same in financing education institutions and how much the curriculum is aligned to ESG subjects.

7. Industry: Industry-run Engineering Institutions can run on the sector-specific requirements of Engineers IITs.

8. MSME: Medium and Small-scale Enterprises are now to stay, and each country focuses on MSMEs as feeders to large industries. MSMEs are required to raise their voice to get their requirements of Engineers met.

9. Professional associations; Bodies like ECI and other business organisations have to speed up their role of continue updation in skills thru knowledge sharing programs

10. Framework to meet future needs of engineers

A study named BeLongEng Project: initiated by Engineers without Borders (EWB) in Australia, is a continuous length: duration project started in 2022 and to run for 20 years with surveys after 1-2-2-3-4-5 years: a first longitudinal study with many collaborating Australian Universities University of Canterbury: University of Technology: University Technology Sydney: The University of Auckland: Queensland and The University of Western Australia.

The study focuses on the role of engineering changes over time: how the skills of Engineers change: how these don't, and where the skill gaps are: including community-centred Humanitarian Engineering for engineers' transition to embrace the socio-technical professional role. [11.2] https://www.mybib.com/#/projects/8BDgXk/citations/new/report

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Sustainable Geographical Engineering Perspectives on Climate Change and Control in Urban and Rural Environments

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"Climate" can be defined as the prevailing or average weather of a place as determined by temperature, precipitation, wind rose, glaciation, frequency of inversion, extreme weather events such as cyclones, tornadoes, cloud burst, typhoons, and hurricanes and environmental quality such as air, water and land quality. Long term variations in average temperature are the most important variables and attributes of climate change.

Change in weather conditions occur in an area over a long period of time such as temperature, humidity, dew point, pressure, volume, wind rose, air movement, photo chemical smog and sunlight energy (photo energy) due to biogenic and anthropogenic activities. Climate change is an evolution in the degree of certainty by biogenic and anthropogenic activities in causing the past half century's rapid rise of 1.1°C in global average surface temperature of 14.9°C from 13.8°C , and climate sensitivity factor of 0.5°C / W/m^2 and net radiating force of 0.9-1.7 W/m^2 , since mid-twentieth century is due to the observed increase in biogenic and anthropogenic greenhouse gas concentrations, the Antarctic and Greenland ice cores, sea floor sediments, glacial movements, changes in ice volume and sea volume and fossil pollen microorganisms. Global warming is the most important environmental challenge for the twenty first century. The climate change and control can be defined as the power to limit and regulate climate change as per sustainable environmental pollution and control standards. The 'greenhouse effect' is one of the environmental problems that have resulted either directly or indirectly from the biogenic and anthropogenic activities. The role of the human population on social and environmental change is given by the equation. I = P X A X T where the impact 'I' of the population on the social and environmental results from the size of the population (P) , the per capita affluence or consumption (A) and the environmental damage by the technologies (T) employed to supply each unit of consumption . As 'P' increases so too does 'T' because supplied to additional people that must be mined from deeper ores, pumped from deeper deposits, transportation further. The per Capita consumption of energy in a nation can be used as a surrogate for the A X T part of from clearing forests for agriculture to mining, industrial, manufacturing, sanitation, road building and extraction of fossil fuels. The magnitude of greenhouse effect of earth is Ts minus Te, where Ts is

actual surface temperature of earth (288 K) and the Te is the earth's "effective and efficient" blackbody radiation temperature of minus 19°C (254 K) . The greenhouse effect is a natural phenomenon due to biogenic and anthropogenic sources of a number of gases and aerosols that is responsible for earth having an average surface temperature 34°C warmer that is 288 K Versus 254 K that it would have if it did not have radiatively active gases and aerosols in the atmosphere. As every doubling of logarithmic emission function and process of CO_2 in to the atmosphere, the global warming surface temperature goes up of 3°C , climate sensitivity factor 1°C / W/m^2 and net radiating force 2-4 W/m^2. It is important to necessary to conduct climate impact assessment (CIA) process to systematically identify and evaluate potential impacts (effects), risks and options for adaptation resilience and mitigation of biogenic and anthropogenic climate change and document as climate research and development (R &D) papers. Three of the most significant terms of CIA process are "climate inventory," "climate impact assessment", and "climate impact statement".

The past three decades have been characterised by passage of the Environmental (Protection) Act (EPA) including Acts on control of water and air pollution, solid- and -hazardous waste management, resource protection and soil and groundwater remediation. In addition to EPA, the community strategies were adopted for sustainable development to address climate change, acidification, and air quality , protection of nature and biodiversity , management of water resources , the urban and rural environment , coastal zones and waste management . It is to be ensured that the balanced planning and decision-making process needed regarding the sustainable environmental and climate development in the public interest.

Project planning and decision-making process should include the integrated consideration of technical, economic, environmental, social and climate and other factors. The most of important of these considerations can be referred to as "three *E* s " (Engineering or technical, Economics, and Environment " in project planning and decision making process. Prior to environmental impact assessment (EIA) process or "Magna Carta for the Environment" , Engineering or technical and economic factors can be referred to as " two *E* s " dominated the project planning and decision-making process. Traditional organizations typically management according to the functions in vertical organizational charts. However, when interactions and interrelations occur among parts of a systems that is among functions and departments it is required to manage as per process in horizontal organization charts. A system of profound knowledge provides efficient organizational planning and decision-making process for the management of parts in isolation and process of cross functional boundaries including optimization of climate change process that is fulfil our common goal or vision of integration of development and environment. "Climate Impact Assessment" (CIA) process. CIA process can be defined the systematic identification and evaluation of the potential impacts (effects) of proposed projects, plans,

programs, or legislation actions relative to the physical-chemical, biological, cultural and socioeconomic components of the total environment and climate. The primary purpose of the CIA process, is to encourage the consideration of the environment and climate factors in planning and decision-making process and to arrive at actions which are environmentally and climate wise compatible. The climate health impacts of projects, programs, plans, polices, or legislative actions should be considered in the decision-making process because of the importance of these concerns, particularly post COVID world, a climate health impact assessment (CHIA) process is proposed. For certain types of projects such as biogenic plants and nuclear power plants, it may be necessary to address psychological impacts and damages of mental health on human, animals and plants. The emphasis is to given in conduction of primary, secondary and tertiary climate impact studies on the physical-chemical and biological climate (natural or biophysical climate environment) and cultural and socioeconomic environment (man-made climate environment). The global agreements that were adopted on various key issues such as climate change, biodiversity, tropical forests, and sustainable development, Viz., Law of the Seas (1954), Stockholm Declaration (1972), Montreal Protocol (1987), Kyoto Protocol (1987), Rio declaration (1992) and The Paris Agreement (2015).

Understanding The Welding Processes and its Technology to it's Application Specialization – A Technological Review

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ABSTRACT:-

The Project Management is all about all the Project Construction Activities in Multi-Disciplinary Engineering Consultative Status in order to take the decisions being Project Manager to the He should be Organized and make His / Her presence into the respectful manners for all the Contracts management with Engineering Calculations reliably put forwarding and co-ordinating with the Design Team.

Agencies and Manufacturers shall have significant contributions from all Spheres of Livelihood. He should be knowledgeable in Commerce and Industry also. Welding Engineering is predominant in any Specific Project Engineering and Management, per se.

IDEOLOGY :

Engineers typically enter the occupation with a bachelor's degree in an engineering specialty, but some basic research positions may require a graduate degree. Engineers offering their services directly to the public must be licensed. Continuing education to keep current with rapidly changing technology is important for engineers.

Numerous professional certifications for engineers exist and may be beneficial for advancement to senior technical or managerial positions.

1. Mechanical Engineering MAIN Subjects.
2. Humanistic and Holistic Approach with well acceptable practices.
3. Engineering Measurements with common measurements.
4. Social Responsibilities with engineering acumen.
5. Intelligence Quotia- Quality Improvement Programs.

MOBILISATION OF WORK AND SITEMANAGEMENT

1. Establish adequate infrastructure and maintain at site comprising of construction equipments aids, tools and tackles and material handing equipments, including setting up of the site office with facilities such as power, water, communication etc. Establishment of organization comprising of Resident Engineer, Supervisory personal adequate of skilled, semi-skilled and unskilled workers.
2. Established infrastructure should be able to complete the entire work in accordance with the agreed time schedule of completion.
3. Concerned person should make all necessary arrangement to load, unload and transport all equipment and technological structure from Railway Station etc. to the stores at site. Al the

equipments neatly at the designated area as directed till erected.

4. The electric power for erection work should be metered and cleared at the rate agreed in the contract. Necessary switches, fuse units, cables shall be installed and maintained, the installation shall comply with the prevailing electricity rules / acts. The person should have clear knowledge about the contract price, terms of payment, scope of work, price/ billing schedules, price variation, and mobilization, of work, delivery schedule and completion schedule.

   The General Application Specialization is Quality Control and Quality Assurance , Field Technical Services and Execution. Conversant with Earth Moving Machinery, Construction Machinery and Excavating & Tools and Tackles /Plant and Machinery along with Mechanical Equipments.

PURPOSE :

The Main Paper Deals with the Welding Engineering Processes and Technology with respect to the Selection of Welding Process , Electrodes and Technological Aspect of the Application is fully dealt in completing the Technical Review over the Selection of Welding Application has it's Vehemence for utility guaranteed.

SELECTION OF WELDING PROCESSES:

Modern Welding process and technologies started just before the end of the 19th century with the development of methods for generating high temperature in localized zones. Welding process which are more common are Gas Welding, Arc Welding which includes Manual Metal Arc Welding(MMA), Tungsten Inert Gas Shielded Arc Welding(TIG), Gas Metal Arc

Welding (MIG, MIG/CO2), Submerged Arc Welding (SAW)etc and Like Electron Beam Welding, Laser Beam Welding, Plasma Welding – High Energy Density processes.

Power Source for Arc Welding Process

Process	Polarity	Output char-acteristics	Current
Shield Metal Arc	Variable Voltage	AC or DC	DCSP TIG
Sub-merged Arc			AC
Flux Cored	Constant Voltage	DC	DCSP
Gas Metal Arc	Constant Voltage	DC	DCSP

DCSP – Direct Current Straight Polarity

In some applications, the SAW process can use Constant Voltage DC Also.

Details of the Welding Processes

I] Gas Welding :

Fusion Arc Welding :

SMAW Shielded Metal Arc Welding

SAW Submerged Arc Welding

FCAW Flux Cored Arc Welding

Gas Shielded Arc Welding :

MIG (Gas Metal Arc Welding)-Pulsed MIG Welding

Hot Wire MIG

Plasma MIG

TIG (Tungsten Inert Gas Welding)-Pulsed TIG

Hot Wire TIG

Spot TIG

II] Electrical Method :

Electric Resistance Welding :-

Spot Welding

Seam Welding

Projection Welding

Upset Butt Welding

Flash Butt Welding

Electro-Slag Welding

Induction Pressure Welding

III] Energy Method :

Electron Beam Welding

Laser Beam Welding

Plasma Welding

IV] Special Methods :

Explosive Welding

Friction Welding

Diffusion Bonding

The welding processes available has their application dictated by the Following Factors:

a) The Material Properties

b) The Type of Weld Joints

c) Their Quality required in the Service Condition

d) Cost and Availability of the Machine

e) Operator's Skill.

A Comparative Study of the Different Processes and their applicability to different materials:

A] OxyAcetylene Gas Welding :

This Process can be used for Carbon Steel, Copper , Aluminium, Bronze Welding.

Sheet metal welding and small diameter pipes welding can be effectively carried out.

Control of flame is very important.

Plates of thickness upto 8mm – 10mm can be welded

Red brass and Yellow Brass are preferably welded by the OxyAcetylene Process to minimizethe vapourization of the Zinc

B] Shielded Metal Arc Welding : This process is widely used.

Almost all engineering materials can be welded. However Low Melting and High Reactive Metals will be difficult to weld.

This process is easy to operate and plates of thickness ranging from 1mm to 25mm can be easily welded.

Preheating is required in some alloy steels.

Welding can be done in all positions.

Edge Preparations are essential in welding thick plates

Manual Metal Arc Welding is commonly used in the erection of structural works like storage tanks, bridges etc.

In open breezy conditions Flux Cored Self Shielded Welding is better suited. Heavier Plates are usually groove welded.

MMA and MIG/CO2 process are used for welding nozzles and other attachments in pressure vessels.

MMA and TIG are extensively used for welding Cupronickel(70:30 alloy) for water

pipes and condenser tubes.

Backing rings are commonly used for welding carbon and low alloy steel pipes by MMA process for Steam Power Plants.

However Backing rings are rarely used for piping in Oil Refineries and Chemical Plants.

C] Submerged Arc Welding :

This process used for Carbon and Alloy Steels and Copper Alloys- generally applied for plates above thickness 10mm.

Best suited for automatic welding in Boilers, Pressure Vessels , Ship Building where high quality welds for larger thickness plates are required.

This process is used for flat and horizontal positions.

Not suitable for Cast Irons.

With U Type of Grooves , Narrow Gap Welding can be carried out by this process and plates as thick as 300-400mm can be welded. In such cases of pressure vessel cylinders and pipes made of large thick plates, automatic submerged arc process is preferred.

D] Gas Metal Arc Welding (MIG and TIG) :

All Engineering Materials except Zn can be welded.

The thickness of plates ranges from 1mm to 6mm.

TIG is applied to all Non Ferrous and Alloy Steel Welding and also for Root Pass in Pipe Welding.

Welding Equipment is more complex and costly.

Difficult to weld small corners and Out Door applications are limited.

MIG Process in Semi Automatic or Fully Automatic form is used for Non Ferrous and Stainless Steel Pressure Vessels Parts.

In the manufacture of Boiler Units, Large Number of Tube Butt Joints have to be made with the tubes positioned at any angle from Horizontal to Vertical with restricted access.

In such cases automated orbital TIG Welding with automatic cold wire feed is used.

Titanium alloy tubes with wall thickness 1.6mm and below are normally welded by TIG Process without filler wire . For heavier pipes , filler metals are used.

E] Plasma Arc Welding :

This process is used for Reactive Metals.

The thickness of the Plate is usually upto 1.5mm.

Plasma Arc Welding Equipments are costly and mechanised PAW is restricted to flat and horizontal positions.

Operating Conditions are quite difficult.

Large amount of Ultra violet and Infra Red rays are emitted.

Thus PAW is used for welding Ni Alloys and Refractory metals for special applications.

It is also used for Refractory Metal Coating, Alumina (Al2O3) and titania (TiO2) on Graphite Nozzle for rockets.

F] Spot, Projection and Seam Welding :

These processes widely applied is Automobile Parts , Tube Manufacturing and Sheet Metal Industries. All Engineering

metals can be welded.

Precautions are necessary in the case of Copper and Aluminium Alloys which are good thermal and electrical conductors.

Flash or Induction Welding is used for Tubular Joints in Boiler Constructions.

At Site , Such Welds are made of TIG for Root Pass and MMAW for subsequent passes.

In Automotive Industries , Radiators are either brazed or Resistance Seam Welded. Upset Seam Welding is used for Exhaust and Tail Pipes. The side seams are usually Spot or Seam Welded.

Seam Welding is normally limited to sheets upto 5mm thick.

Baffles and other interior parts are spot welded in place.

A Typical Application of Projection Welding is in the manufacture of Honey Comb Panels.

Propeller and Drive Shafts are commonly made from Resistence Welded Tubing with theEnd Forging arc welded by Submerged Arc or MIG/CO2 process

G] Electro Slag Welding :

This process is used for Thick Section Welding, 50mm and above , of alloy steels.

This is mainly used for pressure vessels parts, Steel Plant Equipments, Large Shafts etc.

Both ESW and SAW are best suited for thick plates; However ESW is more specialized in its application and less flexible compared to SAW.

H] Electron and Laser Beam Welding :

Stainless Steel , Nickel Base Alloys , Ti and Zr and other reactive metals upto 10 to 25mm

can be welded.

Special Applications are in Electronic Industries, Nuclear and Aerospace Industries.

This process is rather costly.

Laser Welding has the ability to make tiny spot welds. So it is applied in micro electronic circuits.

Laser Beam can weld metals on silicon and Germanium.

I] Diffusion Bonding :

This is widely used in the manufacture of metallic components for electronic tubes.

CLASSIFICATION OF ELECTRODES Electrode

Covering has a large effect on its performance.

The Functions of the Electrode are :-

Provides a vapour shield to protect the molten from reaction with the oxygen and nitrogen of the air.

Provides an ionised path for conducting current from the electrode tip to the work and maintenance of an arc.

Provides flux for cleansing the metal surface of oxides and tying up any oxides as slag that float to the top and may be removed from the finish weld.

Controls the weld profile especially on fillet welds.

Controls the melt off rate of the electrodes.

Controls the penetration properties of the

arc.

Provides the filler metals in additions to that supplied by the core wire.

Adds alloy materials to the weld deposits where a particular chemical composition is required.

SELECTION OF ELECTRODES:-

The selection of electrodes for any particular job has always been a compromise between the requirements of weld quality and overall cost of fabrication. Where quality is important it is necessary to select an electrode type which will give the appropriate weld metal properties.

However the skill of the operators and conditions of the electrode storage and usage must also be considered. In many cases it may be preferable to sacrifice the maximum quality to ensure that sound defect-free welds can be obtained under prevailing conditions of fabrication. Once the required quality has been defined it is possible to select the electrode type and make which will give the lowest fabrication cost or highest production rate. Trends in electrode selections have been apparent for many years. For the highest quality in mild and low alloy steel deposits, basic electrodes are selected. If the parent plate quality is dubious or unknown , basic electrodes are again used. The use of iron powder basic coatings can help the ease of use and deposition rate although it may prevent positional welding.

Selection of Electrodes : Electrodes and their uses.

Mild Steel Heavy Duty Electrodes

Rutile or Basic coated for medium and heavy duty fabrications. The latter is suitable for Carbon and Alloy Steels , Mild Steels, High Strength Steels under restraint and for root runs.

High Tensile Alloy Steel Electrodes

Austenite rutile or Basic coated, used for High Strength Steels including Armour Plates, Joints between Low Alloy and Stainless Steels.

Structural Steel Electrodes

Basic Coated: used for High Strength Structural Steels and copper bearing weathering quality steels.

Ductile Steel Electrodes for Low Temperature

Basic Coated : Used for Nickel Base Steels, 2.5%Ni-C-Mn Steels

Creep Resistant Steel Electrodes

Ferritic and Basic Coating can be used for Cr-Mo Boiler steels with Pre and Post heating

Heat and Corrosion Resistant Steel Electrodes

Rutile and Basic Coating : for 19%Cr9%Ni extra low carbon stainless steels.

Basic Coated for Nb or Ti stabilised 18/8 Stainless Steels

Rutile and Basic coated for Mo Bearing 18/10 Mo steels.

Rutile or Basic coated low carbon stainless steels electrodes for low carbon Mo bearing steels

Basic coated austenitic electrodes for 25% Cr-11% Ni steels and for joints in stainless cladded to mild steels.

Rutile coating austenitic for 23% Cr 11%Ni heat resistant steel containing tungsten.

Basic coated 25% Cr 20%Ni Non Magnetic for austenitic 20/20 steels 12-14% Mn steel electrodes

Basic coating for Mn steel parts steel excavators and mining equipments

Tubular type electrodes for hardfacing Mn steel parts

WELD JOINT CONSIDERATIONS :

General Procedure :-

For every welding job there is one procedure which will give the best including the cost considerations. The main factors that must be considered are :

Type of Joint to be made , Included Angle , Root Opening and Land (Root Face)

Type and Size of Electrode

Type of Current, Polarity and Amperage

Arc Length and Speed

Position of Weld (Flat, Horizontal, Vertical and Overhead)

The Designer (Weld Joint) must consider problems and include them in his analysis of the Joint Design.

A Root Opening is used for electrode accessibility to the base of the joint. The smaller the angle of the bevel , the larger will be the root opening to obtain good fusion at the root.

Backup strips are used on large opening, specially when all welding have to be carried out from oneside. Spacer strips may be used specially in the case of double Vee Joints to burn through.

A Land (Root Face) is provided to have additional thickness of the metal. A sharp feather edge preparation is more prone to burn through than a job with a Land, especially if the Gap is a bit too large. A land usually requires back gouging , if a perfect weld required. A land is not recommended when welding into back up strip , since a gas pocket will be informed.

TYPE OF WELDED JOINTS :

The important consideration of designing a weldment is the selection of the best type of edge preparation for the given application.

During the selection of the Weldment, the following main factors must be considered.

1. Magnitude and Type of Loading, i.e., Static Compression or Tension, Fatigue, Bending, Impact etc
2. The Effect of Warping on cooling
3. The thickness of the Material to be welded

The Basic Types of Welded Joints are :-

Butt, Tee, Corner , Lap , and edge -

The Basic Type of Welds are : Fillet , Square, Bevel Groove , J Groove and U Groove -

The Type of the Joints does not affect the weld.

The definition of a welded joint must include of the Joint and Weld.

GROOVE –WELDS :-

The commonly used Groove Welds have a number of typical properties.

1. Single Groove Welds welded from one side only should not be used for

bending or fatigue loading. It may fail due to stress concentration at the weld root.

2. Single or Double Groove Welds which are welded from both sides can develop full strength.
3. If welds do not exceed completely through the thickness of the members jointed, the joint should not be used for fatigue loading.
4. With single or double bevel type of groove, it may be more difficult to obtain sound weld.
5. If backing strip is used during welding, it must be removed if the joint is subjected to fatigue type of loading.

Various Types of Groove Welds:

Square Groove may be used with Butt, Corner Tee and Edge Joints. Complete penetration of Square Groove Weld is obtained by Welding from Both Sides on material upto 3mm Thick without any root opening and on materials upto 6mm with adequate root opening.

Single V Groove Joints are suitable for materials of 6mm to 19mm thick with a minimum root opening of 60 Deg Single Vee are most suitable for most loading conditions Doubel Vee Groove joints are applicable to Butt Joints for material with thickness ranging from 12mm to 38mm. Control of distortion is also achieved by using Double Vee Groove Joint and welding on alternate sides of the Joint and so balancing the heat input.

Single Bevel Groove Joints include Butt, Tee and Corner Joints. This joint may be used for thickness between 6mm to 19mm. However , the narrow included angle (35 to 45 Deg) of the Bevel Groove Joint makes it one of the least desirable types of Joint.

Double Bevel Groove Joint may be used for thickness up-to 38mm Single U Groove applies to Butt and Corner Joints. U Groove joint consumes less weld metal and gives reduced distortion. U Groove can be successfully applied to thickness range of 19mm. The weld metal width is uniform. Because of rounded bottom at the root ,it is easier to achieve better side wall fusion at the root than in the V Groove type of weld.

Double U Groove Joint id suitable only for Butt Joint. It is economical for plate thickness greater than 38mm and has all the advantages of single U Groove Joint.

Single J Groove joint may be used for Butt, Tee and Corner Joints. It is applicable particularly when the thickness exceeds 19mm. The common root opening angle is 15 to 25 Deg.

Double J Groove joint is capable of withstanding loads of all types in heavy plates. This joint is recommended when the thickness is more than 38mm.

FILLET WELDED JOINTS :-

Though Fillet Weld Joints may require more filler metal than Groove Welds the edges for the Fillet Welded Joints are very simple to prepare and to fit up.

The following points are considered for Fillet Joint:-

Single Fillet Welded Joint is employed in Lap, Tee and Corner Joints. The strength of these joints depend on the Size of the

Fillet. If loading is not severe , these joints are suitable upto 12mm of plate thickness. In fatigue or bending the joint will be weak.

Double fillet welded joint is used for Tee, Lap and Corner Joints. It develops full strength of the base metal and hence can be used for fatigue type of loading also.

Combined Groove and Fillet Joint may be used in certain applications to improve stress distribution within the Joint, specially in Tee and Corner Joints.

COMPARISION OF JOINTS:-

In General Butt Joint is preferable to the single and double fillet or lap joint when

1. The Joint undergoes appreciable tension, bending and shock or fatigue stresses.
2. Over-Lapping parts would decrease thermal conductivity where this is a most important factor.
3. There is possibility of corrosion between the overlapping structures.
4. The maximum saving in weight is desired.

The main disadvantages of the Butt Joint are:-

1. Greater Cost of Preparation.
2. Higher Assembly cost is some of the Products.
3. Lack of Design flexibility in weld size.
4. Greater Skill required.
5. Use of smaller electrodes or filler rods and lower currents for the root layers.
6. Greater shrinkage and higher residual stresses.

The data above is persistent and needs to work out in elaboration which can be possible once

in the Field Activity in transitive functions of the Project Management.

The Functions of the Welding Engineering:- An Aspect :

1. Qualification of welding procedures & Welder's performance for various kinds of joints such as
2. Butt joints, fillet joints, corrosion resistant/Hard facing weld overlays,
3. Tube-to-Tube plate joints, structural T-K-Y joints , Repairs etc
4. Preparation of welding documents such as
5. Welding Procedure specifications (WPS), Procedure Qualification Records (PQR)
6. Welder Performance Qualification (WPQ) records, Welder Continuity Records,
7. Weld maps, Repair Welding procedures, Post weld heat treatment procedures,
8. Preheat & post heat procedures, Procedures for Control & storage of welding consumables
9. Handling troubleshooting, failure analysis, root cause analysis & metallurgical evaluations
10. Selection, technical requirements preparation, estimation and testing of welding consumables
11. Preparing and issuing of technical queries, budget for engineering welding & NDT activities, welding

cycle time on receipt of enquiries from clients.

12. Plan, schedule and control the sub-contractor"s works.
13. Monitoring welder's performance & preparation of weld defect analysis report
14. Establishing welding sequences for structures to avoid distortion
15. Verifying Material test certificates for welding consumables & raw materials.
16. Executing periodical calibration for welding equipments.
17. Assisting for selection of base materials and welding consumables with respect to corrosion control.
18. Involving in the welding and imparting training to welders about the processes & techniques
19. Implementing welding activities as per ASME & ISO 9001 systems.
20. Monitoring inspection activities as per approved Inspection & Test plans
21. Witnessing the destructive testing for procedure qualifications test coupons, welder qualification test coupons & reviewing the Test reports
22. Monitoring NDT activities and review of NDT procedures, NDT reports & interpretation of RT films
23. Preparation of QA/QC documents
24. Prepare/Review of WPS, PQR & witnessing of WPQT.
25. Preparation of Quality plan, Procedures, check lists, weld plan, Heat chart, etc.
26. Witnessing of Hydro test, Pneumatic test, oil & chalk test, smoke test, vaccum test, eddy current testing of tubes, PMI test, U.T, MPT, DPT, etc.
27. Visual Inspection, review of RT films, shot blasting & painting & fire proofing Inspection & Aluminizing check.
28. Good introduction with ASME SEC. VIII, SEC IX, SEC V, SEC II, AWS D 1.1, API 620, API 650, API 1104, etc.
29. Coordinate functions of third party inspection organizations employed to meet code, statutory and company requirements.
30. Integration of ISO 9001, ISO 14001 & OHSAS 18001
31. Implement, establish and maintain HSE Management system.
32. Manage/conduct Audits in line with the audit programme, to ensure compliance and effectiveness of HSE system, evaluation of results and initiate necessary corrective action.
33. Promote and develop Safety culture and support and drive through preventive / proactive activities.
34. Analyze HSE report/data to identify trends, establish performance against target and identify corrective / preventive actions for continuous improvement.
35. Hazard identification and risk assessment / Aspect identification and impact analysis.

SOCIAL ASPECT OF HARMONIUS ENGINEERING WORLD :

The interchanging of educational and

cultural values is to build a new horizon of Love and Respect, in a harmonious and Peaceful Global Village. Modern thinkers on Engineering Education must join efforts, abandoning any care about their individual fame, seeking after harmonious peace for the entire human community, under strong moral principles where their science must be firmly set. First and foremost, we need to make a correct diagnosis about the weak points and the correspondent necessities of the youngest generations. We may establish some objectives as areas to be developed for young Engineers. We are greatly satisfied when we see young Engineers grow up and reach their own financial independence. This is a good thing, but sometimes we expect from them only convenient triumphs and forget other developments, as a truth seeking thought in association with a sensitive heart. On the other side, some how some engineers live in poverty are rescued by education, because it is capable to take them from Good Training and Education that may lead to Engineering Education.

Education in Engineering sense can be a resourceful instrument to achieve an actualized morality, in the very long but passionate travel to Peace establishment. The education of Engineer can be made towards Peace through the development of moral habits and social love, to produce citizens capable of building a peaceful society. This kind of peace education is mostly related to a complete definition of Peace. Although in past times education was synonymous of instruction and restricted to the formation of youngsters. Education is the group of manual and intellectual habits that are accomplished, and the moral qualities that are to be developed, so education is an art more than a science. Aldus Huxley has said that the objective of education is "the guidance of young human beings towards freedom, justice and peace."We conclude that education is the development of physical and intellectual habits, willpower, emotional intelligence, and moral intelligence (moral judgment and feelings). Education endures all life and its objective is the personalization and progressive humanization of the human being.

We may establish some objectives.

Profound Engineering Objectives :

A profound level of Engineering Thought should be based in high and simple moral values.

A solid and at the same time flexible way of thinking, not based in prejudices or pre/ Conceptualisations.

An open mind orientated towards wisdom, beginning in healthy curiosity, all the time, which looks after knowledge and understanding of the Truth.

A capability of study new technologies in a non-stopping manner and in full inquisitiveness.

An operative acknowledge on calculation and recognition of Arithmetical and Engineering Skills.

A creative and innovative thought that may facilitate the Self learning, the Efficiency and the Velocity through Positive Incidence.

Nevertheless Education of Engineering, be the basis for a new generation towards Harmonious Peaceful World of Engineering Constructions.

About the Author

K Venkateshwar is an Osmanian with distinction in mechanical engineering and having three fellowships in the professional organizations namely Indian Institute of Metals, Kolkata Indian Institute of Welding , Kolkata International Council of Consultants, New Delhi And having attained Recognition with the engineering council of India, New Delhi in thermal sciences and engineering and trenchless technologies.

His partial fulfilment of engineering project earned him excellent grade in the viva voce of Osmania University college of engineering examination.

He is working with TATA Consulting Engineers Ltd, Pune. India.

Role of Engineers in Accelerating Economic Growth

- Shri B. R. Jain, Sr. Advisor, Engineering Council of India

Preamble:

An engineer is the driver of the vehicle called industry, which in turn are the drivers of a nation's economy, Consequently, the engineers of a country, are the drivers of that nation's economy.

India aspires to become a $5 Trillion economy by 2025 and no 1 economy by 2047. For any country to become an advanced economy, a robust and flourishing indigenous industrial base is extremely essential. Industries not only create direct jobs but they create indirect employment too. Around an industrial belt, schools, shops, hospitals, offices, roads, communication infrastructure etc., are also created. All these institutions employ a large number of people. Hence for any prosperous nation, a flourishing industrial base is extremely important, necessary and crucial. For accelerated economic growth, massive investments are needed in all sectors. All sectors of economy- Industry, Infrastructure, Agriculture, IT, Financial and other services have to grow fast. These sectors will require engineers/ technologists in large numbers. The engineers have important role to ensure that development projects and programs are properly formulated and implemented for accelerated growth. Our educational institutions have to produce quality engineers who will then need internship with industry to orient them into practical situations.

Sector wise Growth: -

India has one of the fastest growing service sectors in the world contributing a major chunk to its exports every year since past 30 years. The IT industry continues to be the largest private sector employer in India. India is also the third largest start-up hub in the world. The agricultural sector is the largest employer in India›s economy but contributes to a declining share of its GDP. India ranks second worldwide in farm output. The Industry sector has held a constant share of its economic contribution (around 25% of GDP). The Indian auto mobile industry is one of the largest in the world, (mostly two and three wheelers)

2.0 Demographic Advantage :-

- The country is already ranked 3rd largest economy amongst the world's top economies.
- Favourable demographic dividends for the next 2-3 decades. Sustained availability of quality workforce.
- Strong consumerism in the domestic market.
- Strong technical and engineering capabilities backed by top-notch scientific and technical institutes.
- The cost of manpower is relatively low as compared to other countries.

3.0 Indian Economy prior to reforms: -

From the time of Independence of the

country prior to start of the process of reforms which began in 1991, the Planning Commission and the state, rather than markets, determined how much investment was needed and in which sectors.

By cutting off imports India gave a protected market to domestic producers. The protected domestic production was of low quality, obsolete products. It stifled the development of Indian Entrepreneurship. A classic example was the two makes of automobiles and the two wheelers produced in India, remained unchanged for more than forty years. This was the general state of affairs and not an exception. The License Raj provided protection for a class of quite well-to-do Indians, a class ideally suited to dealing with and sharing rents with the members of the License Raj. Even today our private sector industry is still predominantly controlled by these well to do Indians.

In combination with the industrial-licensing regime [the small company policy] had given India the worst of both worlds: too many small and inefficient companies at the bottom, too many large and monopolistic ones at the top. As would be expected, India had a problem of failed firms.

4.1 *Guilds in Ancient India: -*

Maritime trade was carried out extensively between South India and southeast and West Asia from early times until around the fourteenth century AD. Over time, traders organised themselves into associations which received state patronage.

Sean Harkin estimates China and India may have accounted for 60 to 70 percent of world GDP in the 17th century. It is also estimated, till the 13th century, the share of India was more 50% of the world's trade. This collapsed from 22.6% in 1700, almost equal to Europe's share of 23.3% at that time, to as low as 3.8% in 1952, under the British Raj.

Ancient Indian guilds are a unique and multi-faceted form of organisation, which combined the functions of a democratic government, a trade union, a court of justice and a technological institution. Economically it was better to work in a body than to work individually. They had a certain Code of Ethics which was to be followed by all Guild members without fail. A guild member had to abide by both guild and state laws. Thaplyal sketches a brief historical review and discusses various aspects of the laws, apprenticeship, structure, offices, accounts and the functions of these guilds. The trained workers of the guilds provided a congenial atmosphere for work. They ensured advancement of their trade and excellence of their produce. Thus providing all round development of the trade which they controlled.

4.2 *Technical Education*: -

Engineering education in India, in the present form, started during the British era and focused mainly on civil engineering. The Sarkar committee in 1945, recommended the establishment of higher technical institutes based on the Massachusetts Institute of Technology in the four regions of India. This resulted in the setting up of the five Indian Institutes of Technology. The All India Council for Technical Education (AICTE) was set up

in 1945, to oversee all technical education (diploma, degree and post-graduate) in the country.

Parallel to the establishment of the IITs, a network of other engineering colleges of both a general and a specialized nature was also set up. While India was trying to build its higher education base across various fields including Science and Technology, there was a widespread and disturbing trend of significant migration of highly educated scientifically and technologically trained manpower to other countries specially to the United States, which incidentally continues till today.

The focus of the engineering education system in India was to produce engineering graduates to implement operate and manage the growing industry that mainly relied on imported technology, and this is even continuing today. This system is analogous to the system of producing clerks by the education system in the colonial British India.

The disappointing economic progress in India cannot be attributed to any shortcoming in talent among the Indian people or the impediments resulting from Indian cultures. Indians, going out of the Indian System, have succeeded spectacularly in professions and business.

The main reason is the failure of the Indian Industry sector to use effectively this scarce human resource. As in most instances where technology was required by an industry, the industry doyens preferred to import a newer technology and adapt to meet the Indian requirements. The linkage between science and technology with industry is generally missing, except in some pockets such as Space and Atomic Energy. As a result, there is a mismatch between the Research and Development taking place in the Indian Academic Sector with the actual requirement of the Industry. This is amply illustrated by the dismally low number of patents filed by the Indian Academic Institutions vis-a-vis the other industrialized nations. Further whatever research has taken place, it rarely interested the Industry, or was relevant to it. Secondly, whenever the question of introduction of new technology came up, it was left to the public sector to produce and adapt the indigenous technology. As a result, the private sector did not develop the requisite innovative capabilities. The public sector has its own problems of bureaucracy and lack of incentive for continuous improvement. Technological progress, as a consequence, has suffered.

Of the Fifteen hundred thousand engineers that graduate annually today, only 18.43% of them are employable for the Software Engineer-IT services role, while a dismal 3.95% are appropriately trained to be directly deployed on projects.

Firstly, an economy with a large percent of unemployable qualified candidates is not only inefficient, but socially unstable. Secondly, there is a large mismatch in the aspirations of graduating engineers and their job readiness, which can create large-scale dissatisfaction and disillusionment. More than 90% of the engineers coming out of the Indian Institutions are not industry ready. The key reason behind such paltry employability percentages is inadequate preparation in the domain area. The concepts and principles are there in college curriculum, however there is a gap

in teaching and learning pedagogy being followed in a majority of colleges.

The instructors are poorly trained and most of the lectures are delivered impromptu. After the first few lectures the courses begin to lose their directions and in the end the students end up learning almost nothing. The mid semester and the end semester examinations are just copies of question papers from earlier years, the answers of which one can easily mug up in 2-3 days prior to exams. The students generally lose interest in the course after a couple of weeks and then go to the classes only for the sake of attendance. The entire objective of learning is kept on the back burner and full emphasis is given on the completion of the course. Though, the courses are always completed on paper, their efficacies on the academic lives of students remain entirely questionable.

The entire curriculum has to be updated along with reformations in the examination style. If the instructors are not able to finish the syllabus within the stipulated time, then the syllabus should be reduced. Emphasis should be on learning and not on course completion. The priority at these Indian Institutions is currently wrong in each and every manner.

-*We need to increase K-12 participation in math and science, invest more in research, and demand more from existing investments. The key is to align the priorities and objectives of industry and academia. Better industry-university alliances will also provide incentives for companies to keep their research in India.*

-Understand what gives us a long term competitive advantage. We should draw the distinction between "dynamic engineers" (capable of abstract thinking and high-level problem-solving) and "transactional engineers" (responsible for rote and repetitive tasks).

4.3 Indian Industry: -

All of the Industrialized Economies in the world, without any exception, basically have reached that stage purely on the strength of their own Research and Development, their own entrepreneurs and own industry. USA excels in innovations, Europe, particularly Germany, for Engineering acumen, Japan/ Korea in applications and China for its manufacturing prowess. The rest of the world, including India, are markets for their produce. If India wants to become an industrialized nation, then it has to gear up on all fronts, be it education, research and development, Industry, Government or Financial Institutions.

4.4 Importance of manufacturing sector in India's economic growth: -

The Indian Economy can be divided into three basic sectors, 1) Agriculture, 2) Service 3) Manufacturing.

The structural transformation of the Indian economy over the last three decades has been spectacular growth of the services sector, which now accounts for about 50 per cent of the GDP. However, the rapid growth of the services sector much before the manufacturing industry attaining maturity is not a healthy sign. A knowledge -based economy cannot be sustained in the long run unless it is adequately supported by a growing manufacturing economy. Moreover, a service economy cannot continue to thrive on a long-term

basis in a country, where over 80 per cent of the population is educated below the middle-school level. The IT industry in India, which grew by as much as till five years back, has slowed down at present. The demand for qualified professionals in the field has understandably gone down too.

India is blessed with a very large market. Its middle class is larger than an average European country's population. Because of the globalization, more and more Indians are becoming alive to the modern comforts, hence their combined purchasing power is a very lucrative commodity for any industry or for any country.

Because of this large growing market, the Indian economy is firmly on the path of steady growth. Even during the last decade when other countries were in the grip of a massive slowdown, India continued to enjoy a comfortable economic position. This recent spurt in growth is propelled by radical reforms such as the removal of restrictions on foreign investment and industrial de-licensing. Tailoring the EXIM policy to promote exports and aligning the import duties to meet WTO commitments further contributed to this development. This trend is expected to continue driven by a favourable business policy environment in terms of tax cuts, broadening tax base, and reduced interest rates. Some sectors, such as IT, ITES and pharmaceuticals, will compete globally, employing perhaps 2% of the population and bringing wealth to many parts of India. At the same time, around 60% of the population will remain dependent on the agricultural sector, sharing less than one-quarter of India's GDP. Without reform, the agriculture will continue to suffer from endemic underemployment, low wages and monsoon dependency. This will result in continued urban migration, but without the development of an industrial sector this will lead to rising unemployment in the cities. Recognition that this pattern is unsustainable is growing.

It is estimated that India needs to create 7-8 million new jobs each year outside agriculture to stay at its current unemployment level of 7 percent. Manufacturing jobs are ideal for workers, transitioning out of agriculture as service jobs require high level of education and professionalism. The revival of manufacturing sector can create close to 2.5 Million new jobs every year. With the removal of all quantitative restrictions on imports and the falling import tariffs under the WTO regime, it is all the more important for the Indian industry to improve its competitive edge. The sheer volume of international trade with over 70 per cent of the seven trillion-dollar market being in processed manufacturing, strongly indicates the necessity of developing global competitiveness in this sector.

Today Indian markets are flooded with imported goods. With the rise of China as a manufacturing power, the Indian produced items are systematically being replaced by cheaper Chinese versions. Even Ganeshas come from China now. This does not auger well for India.

4.5 Indian Entrepreneurship: -

Indian Entrepreneurship has never been accorded a level playing field right from the time India became independent. From

1947 till 1990, there was an Inspector Raj, thereafter the Indian Economy was thrown open to foreigners. As a result, Indian entrepreneurship was never permitted to develop. Today Indian Industry is dominated by a class of Indians, who cater to the bureaucratic mentality, that a technology is good if there is precedence of its successful usage elsewhere in the world. In case, these doyens, of Indian Industries, have to renovate or set up a new manufacturing facility, they choose to go only for foreign tieups, and never look to the Indian Academia or an Indian source for solutions. By this philosophy, our industry has never excelled, it always remained inferior or a follower of some other country.

If by chance a sector was developed by a group of Indian Entrepreneurs, the Indian Companies are not able to withstand the financial clout of that sector's foreign giant firm. A classic example is that of the Soft Drinks Sector. After the exit of the Coca Cola Company from India in the 1970s, a plethora of Indian brands came out, such as 77 (Double Seven), Limca, Gold Spot, Thumbs up etc, which in quality were far superior than the Coca Cola drink. On the return of Coca Cola and Pepsi to the Indian markets, these foreign brands knew that they would not be able to compete with the Indian Brands, so they squeezed out the fledgling Indian Brands with their financial clout and today there are no Indian players in the soft drink market. This should not be permitted again to happen in any sector or with any Indian enterprise.

4.6 Small scale Sector: -

Another primary reason, for Indian manufacturing sector not being competitive enough, is the significant presence of small-scale unregistered manufacturing units across the entire spectrum, even in classically scale and capital-intensive segments. Such unregistered manufacturing accounts for 23 per cent of the total capital employed and 84 per cent of the workforce. Eighty-five per cent of factories in India have less than USD 200,000 invested in plant and machinery. While this is not to belittle the value of small and medium enterprises, in India, a large number of such enterprises have been created because of artificial market distortions. The deliberate fragmentation of units has been detrimental to competitiveness.

On the rise of China as a manufacturing hub, cheap products are flooding the Indian Markets. As a result, the Indian firms which were earlier producing and marketing those products, are closing their manufacturing units and have shifted/ are shifting to trading. They get the items at a much cheaper price from China, stamp them with their logo and sell them in the Indian Market. Though they have increased their profits, but in the long run this step is highly detrimental to the Indian Industry. This is resulting in a lower availability of jobs for the fresh engineers.

The other important reasons, for the Indian manufacturing sector being not competitive enough, include:

- Poor quality of transport infrastructure across all sectors including port facilities (where productivity is among the lowest in the world), surface roads, railways, airports and waterways.

- High cost of power. Industrial power continues to be among the most expensive in the world. It is about 50 per cent more expensive than in China.

- High cost of capital: It continues to be 10-12 % against international average of 6-8 %.

4.7 The Road map ahead: -

Engineering today affects all walks of life. When we start our day till we go to sleep, our life is connected to an aspect of engineering domain. If India wishes to become an Industrialized Nation by 2030, then its manufacturing Industry has to gear up and be ready to compete with the world. It is absolutely essential that to meet the targets of a developed, robust economy, the engineering fraternity has to evolve into a dynamic and top class force. To achieve that status, all sectors have to contribute.

i) **Government**:-

1) Provide top class transport infrastructure across all sectors including port facilities (where productivity is among the lowest in the world), surface roads, railways, airports and waterways.

2) Substantially reduce cost of power. Industrial power continues to be among the most expensive in the world. It is about 50 per cent more expensive than in China.

3) Substantially reduce cost of capital: It continues to be 10-12 % against international average of 6-8 %.

4) The Government has to play a crucial role in providing the industry with a favourable investment climate in terms of better infrastructure support, institutional finance at affordable rates of interest, and designing fiscal policies aimed at promoting accelerated growth of the manufacturing sector. In particular, special efforts are needed to upgrade infrastructure facilities.

5) Provide a very favourable playing field to the budding entrepreneurs so that Indian owned industry can come up on par with the world majors. These incentives should be much larger in case of technology developed by an Indian entity. According a red carpet treatment to foreigners over Indian entrepreneurs, does not provide a feeling of comfort to Indian Entrepreneurship.

6) Ensure that no industry can function until and unless it has **professional engineers#** mandatorily heading that organization and in sufficient numbers to function smoothly. This step would ensure that the produce of that unit would be world class in quality. Industries to be advised not to encourage engineers black listed by the Federation of the Professional Engineering Bodies.

7) Discourage foreign tie-ups. Encourage by fiscal measures, in-house research and development and adoption of that technology. Foreign tie-ups could be permitted if there is no industry for that

commodity in the country. Once technology of that product is brought in then no further tie-ups should be allowed in future. All developments has to be ensured in-house or in India only. If still foreign tie-ups are gone for then the cost should be made very heavy.

8) The rules and cost of filing of Patents should be made simpler and substantially lowered. The time taken in award of a patent should be the matching the lowest in the world.

9) It should be ensured that each and every industry whether large or small, not less than 5% of its turnover is utilized in R&D. This should be permitted to be off-set in their Tax liability.

 # A Professional Engineer is :

a) **Who is a qualified engineer.**

b) **Who caters to a Code of Ethics, formulated by his/her peers, as was in ancient India's Guilds.**

c) **Who continuously and on a sustained basis keep upgrading his/her skills and knowledge in his/her chosen specialization, and applies this upgraded knowledge in his/her work.**

ii) **Professional Engineering Association/ Institutions**: -

1) Join the Federation of Professional Engineering Bodies and subscribe to the common Code of Ethics, Procedure for registration of Engineers as Professional Engineers and the common procedure of Continuous Professional Development Programs.

2) Become custodian of the concerned engineering stream, as were the Guilds during the ancient India days. Look after the skills and knowledge of its practitioners, their conduct professionally as well as in society, and oversee the development of the engineering stream of which it is the custodian, in line with the uniform system and procedures agreed to and set up by the Federation of the Professional Engineering Body and which is to be followed by all Professional Engineering Bodies.

3) Develop Continuous Professional Development Programs in various forms for:-

a) Technical Educational institutions to make the students there industry ready.

b) For various category and levels of engineers in employment so as enhance and upgrade their skills and knowledge, both for soft skills, as well as hard skills and knowledge relating to the chosen specialization of the registered engineer.

4) Ensure that all registered engineers scrupulously meet the CPD programs requirement for their levels, and keep records of them.

5) Scrutinise the applications of

engineers for admitting them as Professional Engineers and assess them regarding their suitability.

6) Ensure strict compliance of the Code of Ethics prescribed by the Federation of the Professional Engineering Bodies, by the registered engineers. Ensure black listed engineers are not employed by the industry.

7) Involve in the R&D and all development related to that stream of engineering.

8) Keep a watch on the manufacturing industries related to that stream and provide them assistance whenever required so that they can become a world class supplier.

iii) **Individual Engineer:-**

A) **In College:-**

1) Register as Student Engineer and seek and take guidance from the concerned Engineering Professional Body, so as to become industry ready for the industry of his own choice. Undertake Industrial Training with the assistance of the Professional Engineer body, during the full academic duration.

2) At the end of the college curriculum, get assessed for suitability for employment, in the discipline of choosing.

B) **After College:-**

1) On obtaining employment, continue prescribed periodical upgradation of skills and knowledge related to the chosen specialization, by following the dictates of the relevant Professional Body.

2) Continue this upgradation during the whole of active professional life to obtain the maximum advantage.

3) Strictly comply with the prescribed Code of Ethics, so as not to be ~~not~~ black listed.

4) Behave and work honestly and fearlessly as a professional, and with the sole aim to excel in the engineering area of responsibility.

5) Develop capability to identify potential projects and opportunities.

6) Assist in conducting appropriate research, and undertake design and development of engineering solutions.

7) Implement design solutions, and evaluate their effectiveness.

iv) **Industry/ Employer;-**

1) Ensure preferential employment of appropriate level of Registered Professional engineer/s, specializing in the field of expertise of the industry, to be in charge of the engineering aspect / meet the industry requirement.

2) Ensure that all employed engineers subscribe and conform to the philosophy of the registered Professional Engineer system.

3) Facilitate the skill and knowledge upgradation of all employed engineers.

4) Ensure that no engineer, black listed by the Federation of Professional Engineering Bodies, work in that organization. If any engineer is found to break the prescribe Code of Ethics, then bring that infringement immediately to the knowledge of the concerned Professional Body and the Federation.

5) Should ensure providing a conducive atmosphere to all engineers so that they can discharge their duties honestly and fearlessly.

6) Identify potential projects and opportunities and seek assistance from MAs, Academia and the Government.

7) Seek involvement of academia to conduct appropriate research, and undertake design and development of engineering solutions.

8) Implement design solutions, and evaluate their effectiveness, in association with academia and MAs.

v) **Academia:-**

1) Seek assistance and involve the MAs and the industry, in training during the academic years of all engineering students, so that they become industry ready when they complete their education.

2) Assist the industry and the engineers to identify potential projects and opportunities.

3) Conduct appropriate research, and undertake design and development of engineering solutions, in association with the industry and the MAs.

4) Implement design solutions, and evaluate their effectiveness, in association with the industry and the MAs.

5) Assist the MAs and the Industry in upgrading the skills and knowledge of the engineers.

Conclusion:-

After a person clears the assessment of the Engineering Professional Body and takes up employment, there should be a mechanism to ensure continuous upgradation of his skills and knowledge throughout his active life, to result in enhanced technological cap abilities, depending upon his capability.

Technological cap abilities can be best described in terms of four levels: the basic level involves the ability to operate and maintain the existing production plant, the next stage a new production plant based on imported technology, the third level consists of the ability to duplicate and adapt the design for an imported plant and technique elsewhere in the country or abroad, while the fourth and advanced level involves a capability to undertake new designs and to develop new production systems and components.

It would be in the interest of the Industry that it employs such engineers who rigorously follow this path. Further all industry should encourage its engineers to join in this campaign. This would ensure

that the quality of our manufactured goods improve and India is able to compete globally. The government in turn should encourage the industry to facilitate this campaign.

In common parlance, for each individual engineer-

If *I* wish to be successful, first I should become capable and deserving. Success will automatically follow.

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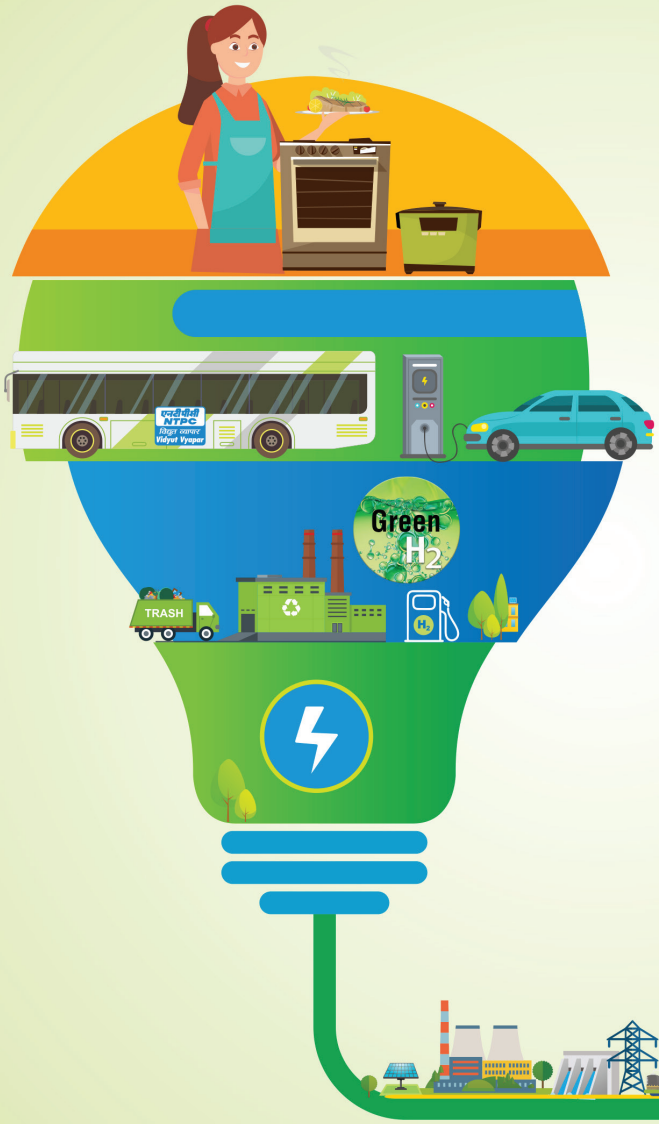

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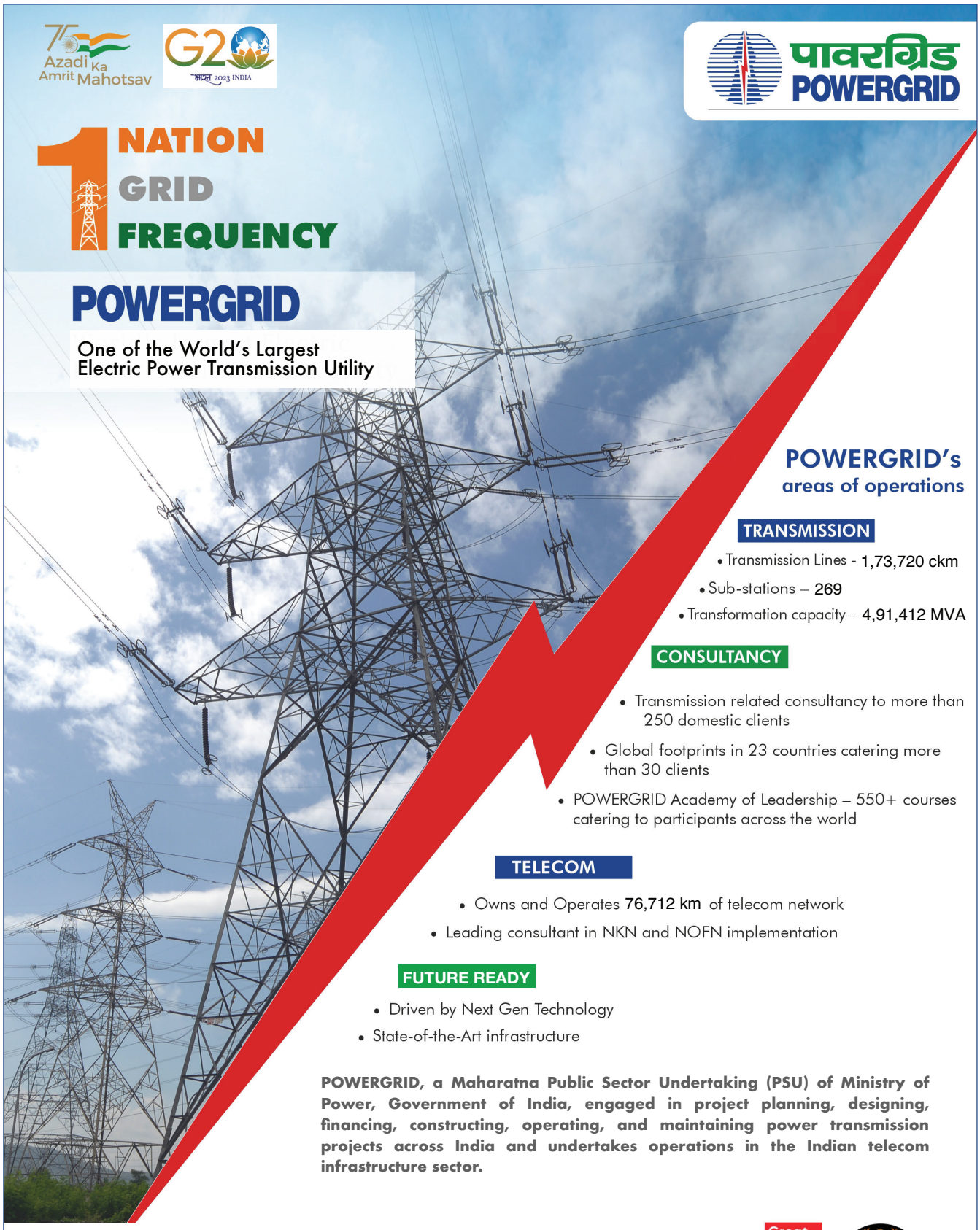

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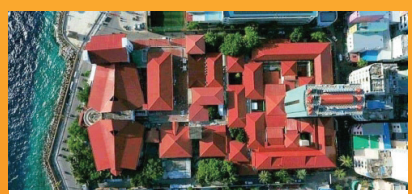

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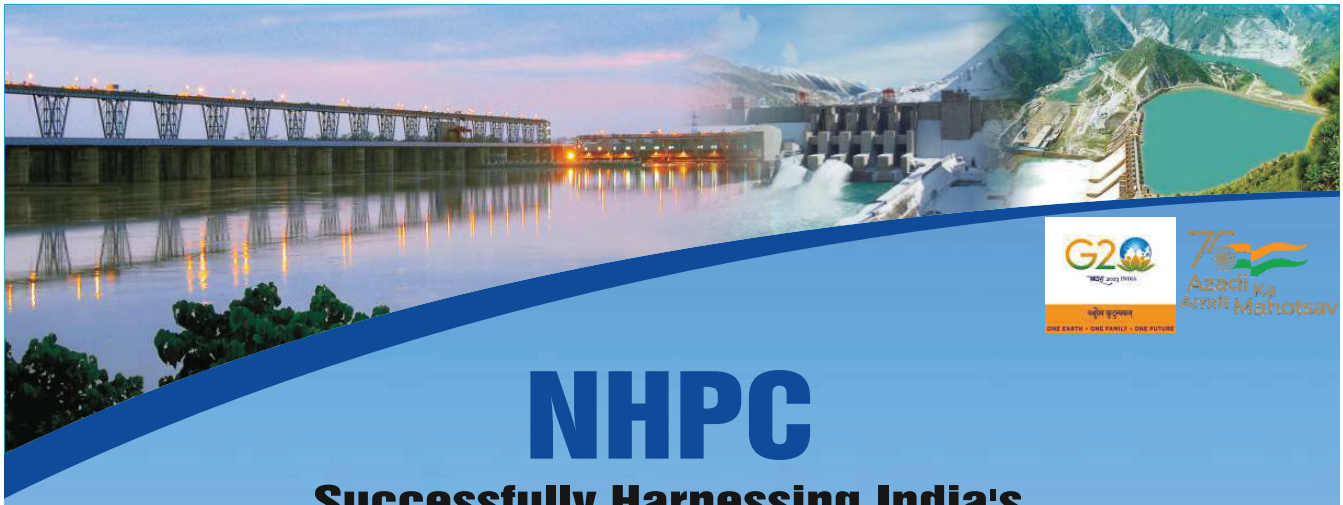

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