Assessment of Civil Engineering Inputs for Infrastructure Development

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FOREWORD

It is indeed a pleasure and privilege for me to present, on behalf of the Indian National Academy of Engineering (INAE), this Research Study on Civil Engineering reviewing broadly the level of demand as well the availability of civil engineers over the next decade or so, particularly in the context of the rapidly increasing thrust by the Government of India on reducing the infrastructure deficit. The recent announcement by the Prime Minister of an investment target of ₹. 46,12,500 crores (USD one trillion approx.) during the Twelfth Five Year Plan Period (2012-2017) underlines the urgency of such an exercise.

In this scenario, we in the Indian National Academy of Engineering (INAE), noting with dismay and concern the dwindling interest in engineering studies, particularly civil engineering, as a career option, decided to take up an in-depth Research Study by a group of four eminent Civil Engineering Fellows of the Academy on the relevant issues and concerns. This group, consisting of Prof. S S Chakraborty, Dr. Prem Krishna, Dr. Nagesh Iyer and Dr. S K Thakkar, identified, analysed and evaluated the emerging multidimensional issues and constraints and recommended an Action Plan to bridge the supply-demand gap in civil engineering and strengthen the nation's efforts for improving our infrastructure – a critical constraint on our development efforts.

With the ardent hope of everyone pledging their efforts in transforming our infrastructure to one of the best in the world, I am pleased to present this Report to all the stakeholders in Indian infrastructure development – the political executives, planners, policy makers, administrators, economists, educationists, industry leaders, sociologists, and all others, - for attention and concerted action.

Dr Baldev Raj

President

Indian National Academy of Engineering

August 2011

PREFACE

Engineering as a profession, over the past decade, has been gradually losing its charm. There could be many reasons for such a development - syllabus not in alignment with the industry requirements, inadequate facilities for training, not-so-competitive or attractive compensation, to mention a few. As a consequence, the availability scenario of engineers, particularly in the Civil Engineering stream, is hardly adequate to meet the current not to mention the substantially enhanced investment allocations in the coming years, projected for wiping out the infrastructure deficit. Such a scenario is a matter of concern to all of us.

In this background, it was heartening, indeed, when the Indian National Academy of Engineering (INAE), decided to undertake a multi-dimensional, multi-sector Research Study to broadly assess, *inter-alia,* the existing availability of civil engineers, the projected annual sectoral allocations, and formulate recommendations for augmenting the civil engineering manpower suitably to meet the present and the future requirements.

Four Civil Engineering Fellows of the Academy, namely, Dr. Prem Krishna, Dr. Nagesh Iyer, Dr. S K Thakkar, and myself were fortunate in being assigned such a relevant and important study. I am indeed grateful to these three friends for their unstinted help, close cooperation and substantial contribution in finalizing this study. Our task is now complete, and the recommendations have been forwarded to the Academy for onward submission to the Government of India for appropriate action. Nothing indeed would be more satisfying to us and the Academy than to find these recommendations engaging the serious attention of all concerned for initiating necessary steps on an urgent basis for enabling the Civil Engineering profession to meet the challenges in a timely fashion, of building the infrastructure so vital for the economic growth of the Nation.

Prof. S S Chakraborty

New Delhi

August 2011

EXECUTIVE SUMMARY

Background

Sustaining and accelerating India's economic growth momentum would require much better and more comprehensive infrastructure support. Developing the necessary physical infrastructure is mainly an engineering intensive enterprise. This is predominantly dependent upon the capability of the Nation with respect to its Civil Engineering supported laterally by the newer streams of technology.

The discipline of civil engineering was relatively out of favor over the past few decades or so. This escalated the infrastructure deficit over this period, (which, anyway, was much below the requirements to start with) and acted as a drag on our economic growth and flattened out the development prospects. In addition, the Civil Engineering profession itself is undergoing changes, with demands for, inter alia, incorporating climate change concerns, disaster preparedness and mitigation measures in its ambit. Civil Engineering has sustained itself over centuries as a fountain of innovation, with respect to materials, construction methodologies, management practices, IT orientation and similar matters. While this is acknowledged, the focus of the Report is on manpower requirement for development of Indian infrastructure.

The research study reported herein has the objective of identifying steps for setting things right, in the limited context mentioned above, by assessing the broad dimensions of the issue, namely the requirement of civil engineers and their availability, and estimating the gap between the two. Further, the issues of quality as well as the measures for bridging the gap are addressed. The aim is to draw a realistic road map for the future that quickens inclusive development of the society as well as the profession.

Structure of the Report

The Report begins with the requirements for the study and delineates the methodology adopted. It takes the performance of the Eleventh Five Year Plan (XI FYP) as a proxy and its sectoral allocations as the template for the XII FYP with an investment target of ₹.46,12,500 crores[1] in the infrastructure sector. It is noted that any estimate of the required Civil Engineering input for absorbing the projected investments would be affected by the uncertainties carried over from the investments not absorbed in the earlier Plans.

As mentioned above, the Report seeks to give a broad overview of the two important aspects, namely, the requirement and the adequacy of the Civil Engineering workforce. The focus is on evaluating the requirement of civil engineers, particularly engineering graduates, to meet the infrastructure needs in various relevant sectors. The subsequent discussion focuses on the availability of well-equipped manpower, from the academia and the research institutions in a sustained manner, facilitated by projected inputs from the industry and a supportive framework of Government policies and programs.

The financial resources required to meet the identified gap between the projected level of infrastructure and developing the human resources to the required level are assessed. Finally, taking note of the inherent uncertainties and risks, some broad suggestions are given for reaching the goals, even if not fully, in the near future.

Availability of Civil Engineers

The Report begins by reviewing the projected investments in various infrastructure sectors, the progress achieved so far, the investments scheduled for the next 10 years as well as the Civil Engineering

[1] *An approximate equivalent of one trillion US Dollars*

manpower requirement for meeting the infrastructural development targets. The disaggregated manpower requirement sector-wise is tabulated as under.

Briefly, in the Roads and Highways sector, it is assumed that 80% of the outlay would be realized through Civil Engineering inputs. Indicative calculations show that an average annual enhancement of the Civil Engineering workforce in the order of 38,000 is necessary to absorb this outlay. For railways, the Indian Railway being keen on upgrading technology, it is only appropriate that civil engineers, with their expertise in GIS and other relevant advanced technologies, will comprise a higher share, say 0.4% in the personnel requirements, implying an addition of 27,000 during XII FYP.

In the Power sector, the annual enhancement, estimated at 26,200 has another important hidden feature: the changes in the skill set of the workforce given that the energy mix would be different with renewable and nuclear power occupying a larger space. Rapid urbanization demands an annual average increment of 35,000 civil engineers to the workforce.

Table A : Consolidated Figures from Chapters 3 to 13

Sector	XI FYP Allocation (₹.Crores)	XII FYP Allocation (assumed) (₹.Crores)	Annual Avg. Graduate Civil Engineer Intake, XII FYP (Projected)	Peak Graduate Civil Engineer Intake, XII FYP (Projected)/Year
Roads and Highways	314,152	734,000	38,400	49,000/2015-16
Railways	261,808	636,000	5,400	8,000/2016-17
Airport	30,968	60,000	105	141/2014-15
Ports, Inland Waterways, and Ship breaking	87,995	180,000	21,000	31,000/2015-16
Irrigation	253,301	540,000	28,000	42,000/2014-15
Energy and Power	666,525	1,472,000	26,200	35,000/2015-16
Environmental Engineering	143,730	225,000	35,800	49,000/2015-16
Telecom	258,439	690,000	330	330 /Each year
Housing, Construction & Real Estate	264,300	810,000	5,500	5,500/Each year
Building & Construction Material	--	--	900	900/Each year
	--	--	1,100	1100/Each year
TOTAL ACROSS ALL SECTORS			**1,62, 735 Say, 160,000**	

Similar judgments with regard to Civil Engineering components of the various other sectors lead to, when totaled up, an average annual enhancement of the order of 160,000, from the current level of about 15,000.

Increasing the availability of civil engineers and requirement of financial resources

Translating the emerging opportunities into reality poses a tough challenge to the nation. In addition, India is poised to reap huge demographic dividends over the next two decades which have to be availed of with a sense of urgency. In this scenario, any programme to improve Civil Engineering education has to be pragmatic and affordable.

While rapid urbanization makes education more accessible, it also requires huge improvements in the quality of technical education. A robust financial framework has to be devised to meet the requirements while accommodating the constraints.

The Civil Engineering community must focus on how to prepare the current workforce better to appreciate and apply the emerging technologies, and develop appropriate curricula that internalizes

dynamism for that purpose in the face of various constraints including, inter alia, availability of funds. The Report explores suitable methodologies in this regard as well as the financial resources needed.

Increasing the availability of civil engineers has two distinct aspects. First, the existing formal Civil Engineering education infrastructure is severely inadequate, adding only about 15,000 graduates to the pool annually, while the requirement assessed after a review of the significant infrastructure sectors is about, 160,000 per annum.

The second aspect is with regard to the skill sets required for a productive, practicing civil engineer. This involves offering dynamic, appropriate training facilities / programs to meet emerging demands from in-service engineers.

It is estimated broadly that ₹.9,700 crores would be required for creating the necessary infrastructure for producing an additional 1,45,000 graduate civil engineers per annum. As these facilities, once created, will be long term assets, it would be justifiable to consider this as a oneoff item. Further, the recurring cost might be recovered on a sustainable basis from the students as normal tuition fees. However, no less important is the fact that, as per AICTE norms, there is a need to find about 40,000 faculty members, across the various sub-disciplines of Civil Engineering.

As regards in-service training, it is suggested that an amount of 0.5% of the project cost, to be absorbed in three years, be added to the cost of the project, as a line item in the project budget. It is estimated that an average of nearly 40,000 engineers over the next 6 years could be given appropriate, project-specific training in this manner, ready to be leveraged subsequently.

There are definite avenues of involvement that the Civil Engineering industry comprising consultants and construction agencies can traverse in increasing the stock of the nation's Civil Engineering graduate workforce in a sustainable manner. Further, such involvement will also enhance the quality of the graduating engineers and fresh graduates while accelerating the process of technology induction.

It is with this in mind, it has been suggested that, under the plan delineated in the Report, 1% of the project cost be line-itemized as training cost in its first year of implementation and be included in the project cost. The resource thus raised will be directed towards establishing new Civil Engineering degree programmes, enhancing the class strength of existing programmes and also train the teachers for more effective teaching, with particular reference to importing best industry practices.

While working out the details it may also be considered whether a short sabbatical, of say 2 months (1/2 semester), may be offered to working engineers to lead the practical initiatives of the academic programmes.

The infrastructure required for such a programme has to be devised in consultation with the "owners" of infrastructure projects and the professional engineering communities / the academic / and the industry associations.

Action Plan

1. Establishing a large number of engineering education institutions, suitably distributed across the various regions of the country, and promoting Civil Engineering within them.

2. There are a number of engineering colleges that do not have a Civil Engineering department. In the interest of a balanced growth in the capabilities of the national engineering workforce, the bias against Civil Engineering in these colleges will have to be removed. Civil Engineering degree courses should be mandated for engineering colleges that seek approval.

- Establishment of institutions should ensure that the campus is a living, self-sustained entity. This alone would promote engineering education in states and regions that are lacking such facilities to the extent required, by attracting faculty and also students to the new establishments.

- The focus may be shifted away from the IIT model and towards the Tier 2 and Tier 3 levels, with a view to prepare engineers for immediate contribution to the profession.

- At 60 students per programme per year, the total cost for establishing a new department in existing institutions or new ones has been worked out as ₹. 9,700 crores to meet the expected demand. This is a one-off cost, and additional requirements may be only on account of new developments in the profession which should be foreseen and planned for proactively.

- If the existing Civil Engineering programmes are permitted to increase their intake capacity by 60, the cost will come down. The advantage would be faster action.

- Science graduates (particularly B.Sc with Physics), may be brought into the engineering stream through specially prepared programmes in existing institutions offering Civil Engineering education. The duration of such courses may be fixed at 2 years with 6 months job experience in industry.

- Requirement of Ph.D. Degree for faculty positions may be relaxed for undergraduate teaching, particularly as a short-term measure, in order to annul the acute shortage of faculty to whatever extent possible. A program of mentoring the teachers should be taken up as a formal requirement as an immediate measure.

- The academia will have to shoulder greater responsibility for shaping a graduate engineer for professional practice in a competent manner. A student must undergo mandatory professional summer training in industry for a duration of four months (2 months each following the 4th and the 6th semester) before the degree would be conferred on him.

- A programme of incentives to enter the engineering profession for rural population and girl students may be thought of to avail with the maximum advantages of the demographic dividend.

The nodal agency for the above recommendations may be the Ministry of Human Resource Development, GoI, and state level authorities with appropriate responsibilities. For promotion of engineering education in rural areas, the Ministry of Rural Development, both at the central and state levels, should also be consulted to enhance local relevance by accommodating the requirements of proximate conditions.

3. A commensurate increase in diploma education needs to be planned. It is noted that there is a significant skew in the distribution of polytechnics among the various regions of the country. Polytechnics, typically, have localized catchment areas and the skills required, are more localized than graduate level competencies.

- The way forward would be to ensure a level playing field of diploma level educational facilities across the nation and any outgo on this count must come from state level mechanisms.

The nodal agency will be the state level authority for technical education.

- Specialized training institutions, called Institutions of Civil Engineering Training (ICET), such as National Institute for Training of Highway Engineers (NITHE) should be established across the country, preferably 4 in number, to serve the 4 regions of the country with faculties mainly from the industry.

- Institutes that have local relevance like the National Inland Navigation Institute (NINI) at Patna will also have to be replicated across the country. The National Power Development Institute has been put on a strong footing through a combination of government and private party participation. The infrastructure like buildings, laboratory equipment, IT infrastructure have been assigned to the government whereas the industry offers its expertise by providing faculty. This model is eminently suitable in this instance, adopted across the nation.

4. The funds for enhancing the Civil Engineering education scenario and also for in-service training facilities must come from the project costs to the extent it can bear without endangering the viability of the project, particularly in the case of the PPP mode of execution. An indicative suggestion would be to include a line item at 1% of the project cost for the year 2011-12 and at 0.5% thereafter for the subsequent years for all projects.

The nodal agencies for this initiative, which will be spread across the various sectors of infrastructure, will be the executing agency of that sector; for example, NHAI for roads and highways.

5. Setting up and managing such a fund for in-service training deserves serious consideration. It is suggested that a Civil Engineering professional entity may be established under the combined auspices of the Industry and the Academia for managing such a fund. This fund will feed the ICETs.

The proposed institutes (ICETs) will primarily cover the function of mentoring of faculty and of in-service training of graduates, apart from keeping track of the dynamics of the changing needs of the profession and the related curricular changes, by:

- Giving Input for academic programmes – curriculum upgrade, faculty training
- Facilitating industry-academia interaction, particularly with respect to the proposed mandatory professional training for award of a degree.
- Planning and design of training programmes, and ensuring their implementation
- Arranging knowledge dissemination events (as distinct from networking events) on specific topics e.g. disaster mitigation / climate change etc. that will have an impact on Civil Engineering practice in an inclusive manner.
- Promoting comprehensive development of the Civil Engineering profession – new technologies, new materials, new design developments etc.

Another important task that ICETs should undertake it to popularize Civil Engineering. What is proposed here is a sort of an outreach programme by the profession into the heart of the high schools in the nation, in urban as well as in rural areas. The proposed Civil Engineering professional bodies (ICETs) along with other industry associations like CII, FICCI and ASSOCHAM may be called in to develop a sustained and intensive programme in this regard. People should be made aware of the Civil Engineering components of what is called sustainable development. This awareness programme, if it is not to descend into futile preaching, must be conducted by civil engineers by actively engaging the civil society. The Civil Engineering curricula must be reworked to make factors and ideas such as “Green” buildings, ecological footprint, embodied energy, smart materials and structures, bio-mimetic, bio-cement, etc. integral.

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Government of India - Ministries & Departments

• Planning Commission, Government of India

• Ministry of Statistics and Programme Implementation (MOSPI)

• Ministry of Coal

• Ministry of Steel

• Ministry of Petroleum and Natural Gas

• Ministry of Chemicals and Fertilizers

• Department of Pharmaceuticals

• Ministry of Power:

  - Central Electricity Authority (CEA),
  - State Electricity Boards (SEBs)
  - Ministry of Non-Conventional Energy Sources

• Ministry of Railways and Zonal Railway Organizations

• Ministry of Shipping Road Transport and Highways (MOSRTH)

• Ministry of Civil Aviation

• Ministry of Environment and Forests (MoEF)

• Ministry of Urban Development (MoUD),

• Ministry of Water Resources

• Department of Science & Technology

Government Agencies

• Coal India Limited

• Steel Authority of India Limited (SAIL)

• Institute for Steel Development and Growth (INSDAG)

• Oil and Natural Gas Corporation (ONGC)

• Engineers India Limited (EIL)

• National Council for Cement and Building Materials (NCCBM)

• National Thermal Power Corporation (NTPC)

• National Hydro Power Corporation (NHPC)

• Central Water and Power Research Station (CWPRS)

• Central Power and Research Institute (CPRI)

• WAPCOS Limited

• Council of Scientific and Industrial Research(CSIR)

• Building Material and Technology Promotion Council (BMTPC)

• Housing and Urban Development Corporation (HUDCO)

• National Highway Authority of India (NHAI)

• Airports Authority of India (AAI)

• Inland Waterways Authority of India

• IRCON International Limited

• Research Design and Standards Organization (RDSO)

• River Basin Authorities

• Indian Institute of Technology, Mumbai – Department of Energy Science and Engineering

• National Skill Development Corporation (NSDC)

• National Sample Survey Organization (NSSO)

• University Grants Commission (UGC)

• All India Council for Technical Education (AICTE)

Other Agencies

• Construction & Real Estate Developers Association of India (CREDAI)

• Construction Industry Development Council (CIDC)

• Federation of Indian Chambers of Commerce and Industry (FICCI)

• Confederation of Indian Industry (CII)

• The Associated Chambers of Commerce and Industry of India (ASSOCHAM)

• Builders Association of India

• Indian National Group of the International Association of Bridge and Structural Engineers, Zurich (ING-IABSE)

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CHAPTER 1

INTRODUCTION AND METHODOLOGY

1.1 Project Background

Indian economy has shown robust growth in aggregate terms over the past decade, the GDP crossing the psychological barrier of USD 1,000 billion just few years ago. In the process, the secondary and the tertiary sectors of the economy have gained more prominence. The focus on inclusive growth has also widened the geographic spread of economic activity. However, it stands to reason that such growth cannot continue to take place unless severe deficiencies in infrastructure are removed. Further, it is realized that apart from being sufficient in terms of quantity and quality, the infrastructure facilities have to be dispersed widely to reach all parts of the country. Connectivity to ensure efficient movement of people, goods and services should be a major over-riding concern. Keeping this in view, a phase of rapid infrastructure development is already underway.

The XI FYP had noticed the looming infrastructure deficit and provided USD 500 billion for various programs across all the sectors. However, the ongoing development process is pushing the demand for infrastructure further. In this scenario, the Prime Minister of India recently announced an investment target of ₹. 46,12,500 crores for infrastructure development in the XII FYP, twice that projected in the XI FYP, indicating a quantum shift.

Such a mandate immediately compels an analysis to assess the capabilities for absorbing the projected investment in a fruitful manner and is the motivation for the current research initiative, sponsored by the Indian National Academy of Engineering (INAE). This research study seeks to review relevant issues and concerns for facilitating policy changes for ramping up Civil Engineering education, training and employment, upgrading knowledge as well as utilizing the available manpower (including senior citizens) more effectively for leveraging their knowledge. Hence, it is necessary to assess the ground reality by looking into the recent past, identifying deficiencies, and ascertaining future requirements, in order to frame realistic plans to realize the targets set.

1.2 Infrastructure Development and Civil Engineering

Development of physical infrastructure is an engineering intensive enterprise. Infrastructure plans are often not realized on the ground because of systemic problems with regard to the number as well as the quality of Civil Engineering manpower available and employed, and also its distribution amongst the various competing sectors.

Amongst the myriad engineering facets, Civil Engineering has deep linkages with other engineering disciplines. Emphasizing the interactions between various sub-disciplines of Civil Engineering and other engineering applications is sine qua non for effective engineering inputs for realizing the projected investment levels. Also, after execution of the project, engineering inputs continue to be required in the operation and maintenance phase. Various activities under the rubric of asset management do require engineering expertise. Hence an assessment of Civil Engineering input levels, particularly in terms of manpower requirements is essential for achieving the infrastructure targets. It is in this background this research initiative focuses on Civil Engineering.

With the advent of new fields of engineering and technology, as well as management, offering more attractive remuneration packages, Civil Engineering (along with a few other traditional fields of engineering) seemed to have lost its attraction as a career prospect. The recent (and continuous) emphasis on infrastructure development would certainly bring about a change of attitudes towards these professions, particularly Civil Engineering.

Studies have been carried out earlier to sketch the overall manpower scenario in this respect. The figures brought out cover different time spans and are of great relevance in understanding the general picture which includes, apart from engineers, the associated trades as well. Though the parameters for the study contained in this Report – time span and the focus on the needs of Civil Engineering alone – are different to the earlier studies, the above mentioned material provides very useful background information, and has been annexed (see Annex 1/1).

It is evident that a meaningful aggregate scenario to assess, the requirements both qualitative and quantitative of civil engineers of the desired capabilities across various sectors of infrastructure can only be built upon hard disaggregated data. This is so, as each sector has a distinct characteristic which imposes severely upon the inputs of Civil Engineering.

To enable disaggregation, Civil Engineering linkages to various spheres of economic activity as well as the enabling provisions, namely infrastructure have to be identified. This is shown schematically in Fig. 1.1.

Besides manpower requirements Civil Engineering inputs invoke a wide range of issues. The manpower related scenario is of course the over-riding concern but inputs are required into a number of other issues as well. Primary amongst those is research for developing new philosophies in design – the "green" building concept, sustainability under natural disasters – new materials, recyclability of building wastes. This, in turn also requires manpower – highly skilled and trained. This Report has therefore concentrated upon manpower scenario. It ought to be mentioned too that besides ensuring that projected manpower needs are met to implement the infrastructure plans, it will need to be ensured that the requirement for the conventional materials is also met besides supplementation by new materials that may be developed.

Many infrastructure elements have spatial extent as well as network characteristics, viz. road / rail network and transport, power transmission and distribution, water supply and distribution etc. Planning and execution of these projects with a large Civil Engineering component are facilitated these days by new emerging developments viz. Geographic Information System (GIS). Many of these projects need extensive involvement of civil engineers with project-specific capabilities. This aspect would be taken into account and necessary requirements incorporated while assessing manpower input for project implementation.

1.3 Objectives and the Scope of the Study

While infrastructure is a wide ranging term, this Report focuses on physical infrastructure dealing predominately with Civil Engineering. However, it takes note of social infrastructure including recreational facilities, tourism and public buildings. Hence, the sectors considered herein are:

- Traffic and transport system
- Roads and highways, Ports and harbors, Inland waterways, Aviation, Railways
- Water supply, sewerage and solid waste management
- Power, including non-conventional and renewable
- Urban area planning
- Telecommunication
- Construction, housing and commercial real estate development
- Social infrastructure including recreational facilities, tourism and public buildings

- Industries, automobile, heavy industry including shipping
- Steel (structural steel, reinforcement)
- Cement
- Sustainable and / or engineered materials.

CIVIL ENGINEERING INPUT FOR INFRASTRUCTURE DEVELOPMENT

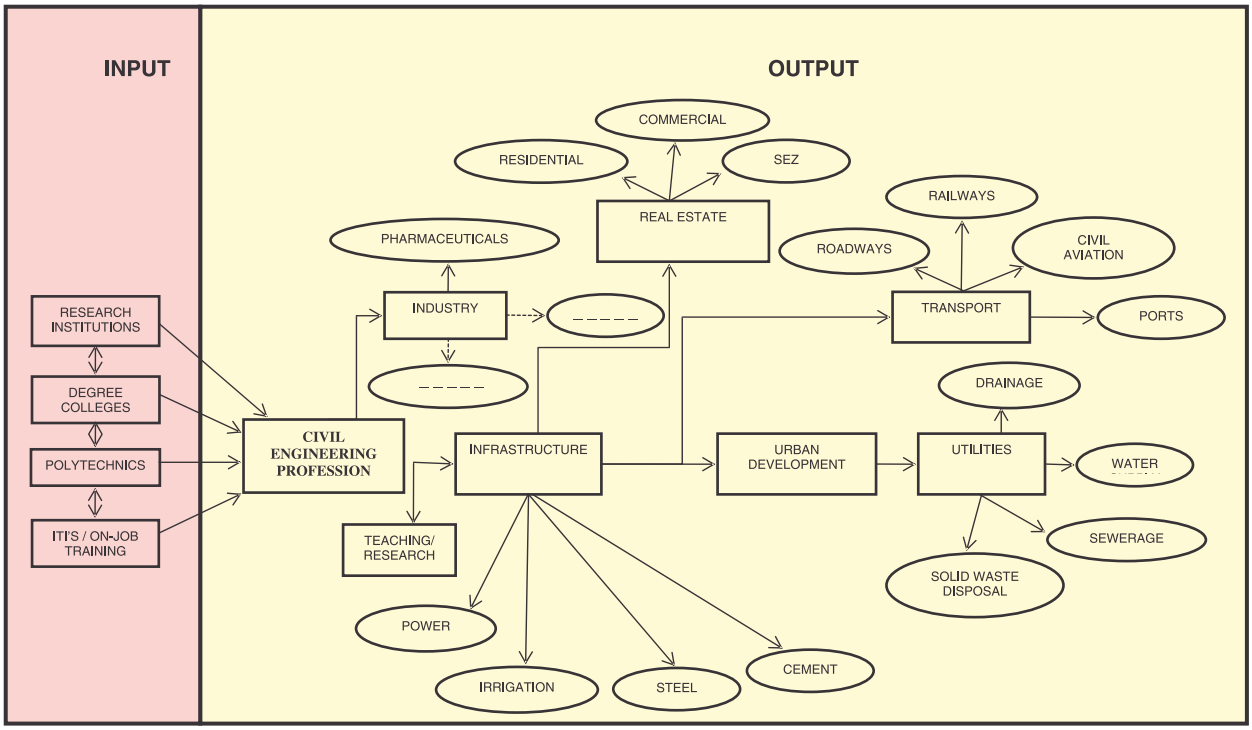


Fig. 1.1 : Civil Engineering input for Infrastructure Development

The objectives of the study are to:

(a) Assess the gaps between the targets and the achievements during the XI FYP period

(b) Estimate the current Civil Engineering manpower deficiencies

(c) Estimate the Civil Engineering manpower required for achieving the XII FYP targets

(d) Determine the number of civil engineers with required capabilities graduating annually from engineering institutions as well as estimate the leakages to other fields such as Management (particularly finance), Information & Communication Technology (ICT) and other disciplines

(e) Assess and plan possible ways for enhancing supply of trained manpower to absorb the planned investment

(f) Identify methodologies; including government incentives to the academia and the industry to increase the number of civil engineers graduating every year and also increase the retention rate (reduce leakage)

(g) Identify infrastructure sectors in which Civil Engineering could play a prominent role, and enumerate the specifics of the required input in each of them.

The requirements of the accelerated programme of infrastructure development would be assessed and the needed remedial measures identified. This would include inadequacies in number as well as the quality of civil engineers graduating from different institutions. The pace of absorption of evolving technologies, including ICT - a measure of dynamism - in the industry, as well as the pace of their introduction in the academic curricula in the institutions will be reviewed.

The study would conclude by setting out a road map, indicating the required resource commitments.

A major portion of the Report is divided into two distinct parts, nominally separated as Demand Side (Chapters 3-13) and Supply Side.(Chapter 14). The former deals with the demand for and on civil engineers to meet the infrastructure and growth requirements. The latter focuses on the supply of appropriate, knowledgeable and capable manpower, from the academia and the research institutions in a sustained manner, along with inputs from industry and a supportive government policy framework.

1.4 Demand Projection

The demand for civil engineers would be influenced by:

- Population increase and pace of urbanization
- Aspirational lifestyle demands of urban and rural populations
- Economic growth, export orientation (transport, logistics, reliability of service delivery in sectors like water, power, communication)
- Increase in technological sophistication and services because of scientific progress / international competition

Baseline numbers need to be established for successful projection of the demand of Civil Engineering manpower. This would enable estimation of the current deficiencies in terms of facilities available in quantity and quality. Thereafter, the projections may be matched with the demands at acceptable levels of service delivery.

1.5 Supply Projection

The important factors influencing supply are:

- The size and rate of change of demand for civil engineers
- The contours of Civil Engineering education – number, size and distribution of educational institutions
- The dynamics of curriculum change – stakeholders' involvement
- Gaps in educational and research personnel – particularly number of faculty members, of research personnel and the like.

Industry sources have said on various occasions that graduating engineers are not sufficiently exposed to industry practices to meet the requirements of the employers. Every effort should be made to shorten the gestation time.

The problems in augmenting teaching capacity were clearly brought out in the INAE document entitled Profile of Engineering Education in India: Status, Concerns and Recommendations by G. Biswas et al. The recommendations therein need to be followed up, in the context of this study, with focus on Civil Engineering. There is a need to look beyond for further avenues by identifying resource gaps, in faculty / laboratory facilities etc. as well as significant practical training opportunities.

1.6 Demand-Supply Matching

This research study seeks to present an action plan to implement its recommendations. Civil Engineering input requirements have been determined on the basis of current deficiencies and future projections. Hence, the study focuses on the required resource augmentations - human, technological, capital equipment, and institutional. It then proceeds to develop the plans and indicate the ways for implementation through recommendations regarding teaching, training and industry practice.

Fig. 1.1 indicates how Civil Engineering inputs from various degree colleges, polytechnics, ITIs and various others on-job training schools impact on infrastructure development. Out of the total number of engineering degree awarded in our country only 4% relate to Civil Engineering. A very small number opts for research and teaching because of various reasons like salary scales / lack of incentives and opportunities.

While a dominant portion of Civil Engineering input is involved in the infrastructure sector, a significant segment serves in various industries e.g. automobiles, pharmaceutical. Steel and cement industries employ a large number of civil engineers in the production phase and a smaller number during the operation and maintenance phases. Given, for example, the current low per capita steel / cement demand in India, these sectors would require the services of a larger number of civil engineers for enhancement of their production capacity.

Apart from these sectors, the services sector, as well as the real estate sector because of rapid urbanization and chronic housing shortages would become a major employer of civil engineers for projects like SEZs / aerotropolises / hospitality and entertainment and other expanding sectors.

1.7 Approach and Methodology

The research work is based entirely on available data, gleaned from various sources, viz. Ministries and Department of Central and State governments, industry associations, educational institutions as well as various relevant reports. Table 1.1 gives a list of organizations contacted for data collection. The help and cooperation received is gratefully acknowledged.

Table 1.1 : Data Collection Details

Infrastructure and segments	**Ministries, Government Departments and other Govt. Agencies**
Extraction & manufacturing industries	
• Coal	• Ministry of Coal
• Iron ore	• Ministry of Steel
• Oil	• Ministry of Petroleum and Natural Gas
• Gas	• Coal India
• Cement	• SAIL
• Steel	• INSDAG

• Automobiles	• ONGC
• Capital goods	• EIL
	• NCCBM
	• BMTPC
	• CSIR
Power	**Ministry of Power**
• Fossil fuel	• CEA
• Hydro	• NTPC
• Nuclear, Non-conventional and Renewable	• NHPC
• Other	• MNRE
	• State electricity boards or equivalent
	• CWPRS
	• CPRI
	• WAPCOS
	• Private power producers
Construction, Housing & Real Estate	
• Housing	• CIDC
• Commercial	• CSIR
• Hospitality	
Transportation	
• Roads and highways	• Indian Railways and Zonal Railways
• Ports and harbors	• Ministry of Shipping
• Inland waterways	• Ministry of Road Transport and Highways
• Aviation	• Ministry of Civil Aviation
• Railways	• NHAI
	• CSIR
	• AAI
	• Inland Waterways Authority of India
	• IRCON International Ltd.
	• RDSO
	• MoEF
Urban Engineering	
• Urban transport	• MoUD
• Water supply	• HUDCO
• Sewerage	
• Solid waste management	
• Drainage	
Water resources	
	• Ministry of Water Resources
	• Various river basin authorities
	• MoEF

1.8 Data Analysis Template

- Compilation of investment figures for various infrastructure sectors during the X and XI FYP
- Sector-wise investment details
- Planned expenditure for various Government initiated programs.

- Technical / skilled manpower shortage - in consultancy, contracting and project management, and client services
- Constraints in bridging the gap between demand and supply of civil engineers to match the investment plans proposed for the XII FYP.

1.9 Analysis, Issues and Recommendations

- Analysis of past performance of various sectors, investment involved for execution of the projects and physical progress of the projects (targets and achievement)
- Industry's response to past demands
- Future demand of civil engineers to execute the projects during the XII FYP
- Gap analysis
- Recommendations.

Manpower scenario based on other study reports

It is projected that a quarter of the increase in the world's working population will occur in India between 2010 and 2040 and it would add more than 300 million working age adults. In 2020, the median age in India is expected to be 28, compared with 37 in China, 38 in America, 45 in Western Europe and 49 in Japan, thereby making India the single largest positive contributor to the global workforce over the next three decades. However, the ability to reap the ensuring dividend by India will depend on how capable and skilled its workforce is. The present supply is just one-fifth of the annual demand of 15 million people. A study by The Associated Chambers of Commerce and Industry of India (ASSOCHAM) on "Emerging Future Jobs" indicates that the Indian economy will create 87.17 million jobs by 2015. However, only 25 percent of graduates have the necessary skills for immediate employment. Another study by The National Association of Software and Services Companies (NASSCOM) and McKinsey (a global consultancy company) in 2005 showed that only one in four engineers were employable or could be trained for a job.

Although building construction and real estate sector employ 33 million people1[1], (See Fig. 1/1-1) second only to the agricultural sector, the incremental workforce requirement is around four million people over the next seven years to sustain the current growth rate. Around 30% of 33 million are employed in real estate segment and the rest are absorbed in the infrastructure segment. The construction industry thus has to address the problem of sourcing manpower and also that of the shortage of contractors. The industry is highly fragmented, as the entry barriers are low because of low fixed capital requirements. It was estimated in 2004 that out of more than 3 million construction entities (including housing contractors) only around 28,000 were registered. Fragmentation is more in the housing segment than in industrial / infrastructure segment, as the unorganized sector accounts for 75% of the same. Besides, the industrial / infrastructure sector requires far more technical expertise and it is difficult for small players in the unorganized sector to compete effectively. The employment scenario in the construction industry in 1995 as well as in 2005 at five levels namely, a) engineers, b) technicians, c) nontechnicians / clerical, d) skilled workers and e) unskilled workers are presented in Table 1/1.1 with qualification-wise distribution in Table 1/1.2.

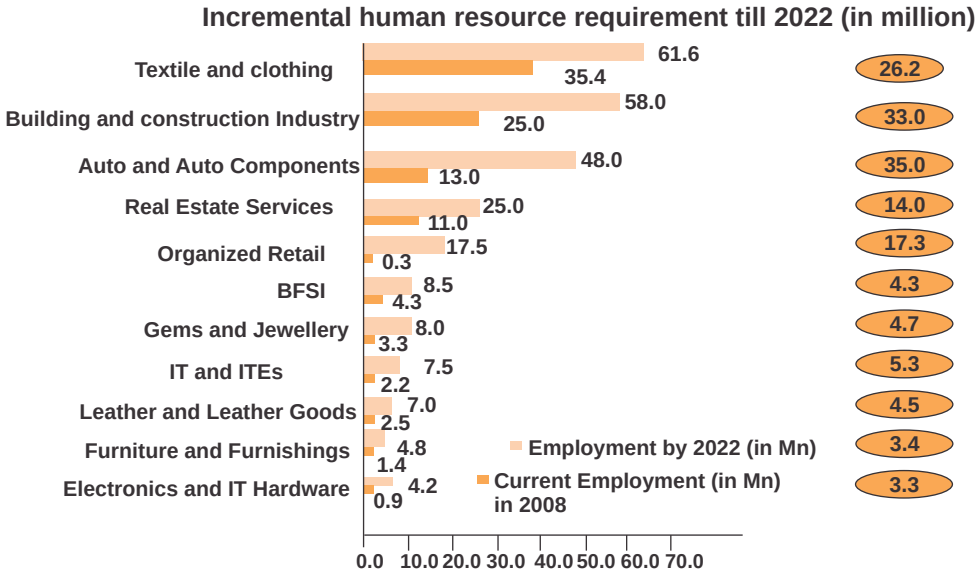


Fig. 1/1-1 : Illustrative Human Resource Requirements across Select Sectors till 2022[2]

[1] "Human Resource & Skill Requirements in the Building, Construction and Real Estate Services", NSDC report
[2] National Skill Development Corporation (NSDC)

Table 1/1.1 : Employment in Indian Construction Industry[3]

Occupation	Numbers employed in 1995(in 000's)	Numbers employed in 2005(in 000's)	% of Total (2005)
Engineers	687	822	2.65
Technicians & Foremen	359	573	1.85
Clerical	646	738	2.38
Skilled-Workers	2241	3267	10.54
Unskilled Workers	10,670	25,600	82.5
Total	14,600	31,000	

Table 1/1.2 : Distribution of Human Resource by Education Level across the Industry[4]

Educational Qualification	Distribution
Ph.D/Research/CA/MBA/etc.	1%
Engineers	2%
Diploma or equivalent certification by other agencies	2%
ITI and other vocational courses	13% - 14%
10th Standard or below	81%

The skilled talent pool spans across a multiplicity of trades / professions eg. crane operators / electrician / welders / masons / plumbers and carpenters. The National Skill Development Corporation (NSDC) projections for incremental human resource (HR) requirement between 2008 and 2018 are about 33 million. The total requirement considering the real estate sector and infrastructure together for the year 2017-18 is expected to be about 69 million. The four-year incremental breakup for infrastructure and real estate is given in Table 1/1.3. Qualification-wise and function-wise breakups are provided in Tables 1/1.4 and 1/1.5 respectively. The incremental human resource requirement is based on a) the investments in the XI FYP and projected investments into various sectors b) the amount of man-days required for completion of projects in sectors like road, rail, power, etc. for a specific investment size and c) estimates on productivity increase. The GDP growth and size of construction and real estate services have been projected based on economic modeling by NSDC.

Table 1/1.3 : Projected Human Resource Requirement between 2008 and 2018

(in 000's)[4]

	2008	2012	2018	Incremental
Infrastructure	25,177	33,868	48,280	23103
Real Estate	10,790	14,515	20,692	9902
Total	**35,968**	**48,383**	**68,972**	**33005**

[3] *Report of the Working Group on Construction for the XIth FYP, Planning Commission, Government of India*

[4] *"Human Resource & Skill Requirements in the Building, Construction and Real Estate Services", NSDC report*

Table 1/1.4 : Estimated Incremental Human Resource Requirement for Infrastructure & Real Estate between 2008 and 2018

(Arrived at based on the proportional incremental projected value using NSDC Report) *(in 000's)*

Ph.D/ Research/ Design	Engineers	Diploma	ITI and other vocationally trained	Other Graduates	CA/ MBA/ etc.	10th standard & below/ dropouts
391	783	783	4,930	391	391	25336

Table 1/1.5 : Estimated Incremental Human Resource Requirement across the Workforce (including skilled workforce) between 2008 and 2022

(Arrived at based on the proportional incremental projected value using NSDC Report *(in 000's)*

Profile of People	Incremental Requirement
Project Managers and Engineers	391
Supervisors	391
Foremen	783
Crane Operators	5
Electricians	391
Welders	391
Bar Benders	1,176
Masons*	1,176
Plumbers	979
Carpenters	1,567
Surveyors	39
Others (including Quality, Glazing Workers, painters, equipment operators)	380
Minimally Educated	25,336
Total	33,005

** Masons include different types of masons such as stonework masons, tiling masons, plastering masons, polishing masons*

An estimate of major sectors where engineers will be required till 2018 is given in Table 1/1.6.

Table 1/1.6 : Major Segments where persons would be employed in Construction till 2018 - Estimated Total and Incremental Human Resource Requirement[4]

(in 000's)

Activity	Total requirement in 2018	Incremental Requirement between 2008 & 2018
Real estate- housing & building	20,692	9,902
Electricity	16,332	7,816
Roads and Bridges	7,410	3,545
Railways(including MRTS)	6,416	3,071
Irrigation	8.848	4,235
Water Supply and Sanitation	5,020	2,402
Ports	2,112	1,010
Airports	736	352
Others	1,406	672
Total	**68,972**	**33,005**

Successful and timely implementation of infrastructure projects would require a well thought out and coordinated plan for training / developing quality manpower / human resources, taking into account the inherent lags / obstacles in the process. Substantial increase in financial allocations alone would not yield the desired results in the absence of trained manpower / professional experts from various disciplines - particularly Civil Engineering, in the context of this Report. In India today, flood gates of opportunity are wide open for civil engineers on a scale never witnessed before. The unprecedented impetus we are witnessing today in development of physical infrastructure calls for deployment of a large number of competent civil engineers. The demand far outstrips supply and the situation is expected to continue, though in slightly lesser degrees, for the next decade or more, as Civil Engineering professionals cannot be produced overnight. What is needed is a significant change and transformation in the education process in association with all the stakeholders namely, academia / Government of India as well as the State Government ministries / departments / industrial associations (Chambers of Commerce) / R & D organizations / labour organizations and the like.

CHAPTER 2

XI FIVE YEAR PLAN – TARGETS AND ACHIEVABLES

2.1 Introduction

The XI FYP (2007-2012) set for itself an ambitious target of raising investment in infrastructure from around 5% of GDP in the base year of the Plan, i.e., 2007-2008, to 9 % by its terminal year, 2011-2012. The target, based on specific assumptions, projects an investment requirement of ₹ 20,56,150 crores for ten infrastructure sectors over the five year period and represents an increase of over 135% beyond that of the X FYP. A log-linear Business As Usual (BAU) projection would have reached only up to ₹ 15,52,657 crores.

The contours of infrastructure development during the XI FYP is also affected by current discussion on broad-basing development and adopting an inclusive approach. This would require that resources, particularly human resources, are developed and made available across the country.

2.2 Investment projections

The XI FYP investment projections assume an annual GDP increase of 9% and a varying increment in the annual Gross Capital Formation (GCF) through the tenure of the Plan, from 5.75% in 2007-2008 to 9.00% in 2011-12. Fig. 2.1 indicates the sectoral allocations and Table 2.1, the projected numbers (Top-down approach). The sectoral analysis and allocations amongst the ten sectors are given (Bottom-up approach) at Table 2.2.

It may be mentioned here that after these projections, the global economy had witnessed a strong down turn, yet India is one of the few countries that was not impacted severely. The Mid-Term appraisal of the XI FYP makes it clear that on the aggregate, the gap between the original and the revised projections is much less than 1%. However, when disaggregated, there are significant differences across sectors, for example, railways loses nearly 3% of its share, water supply and sanitation, more than 1.5% (this may be particularly glaring in the scenario of fast urbanization), oil and gas pipelines gains 5.5% etc. The relevance of such variations for this research study is the differentials in Civil Engineering input required for realizing the investment targets among the various sectors. This is a level of uncertainty that has to be absorbed in the assessment of the requirement of Civil Engineering resources for realizing the infrastructure targets.

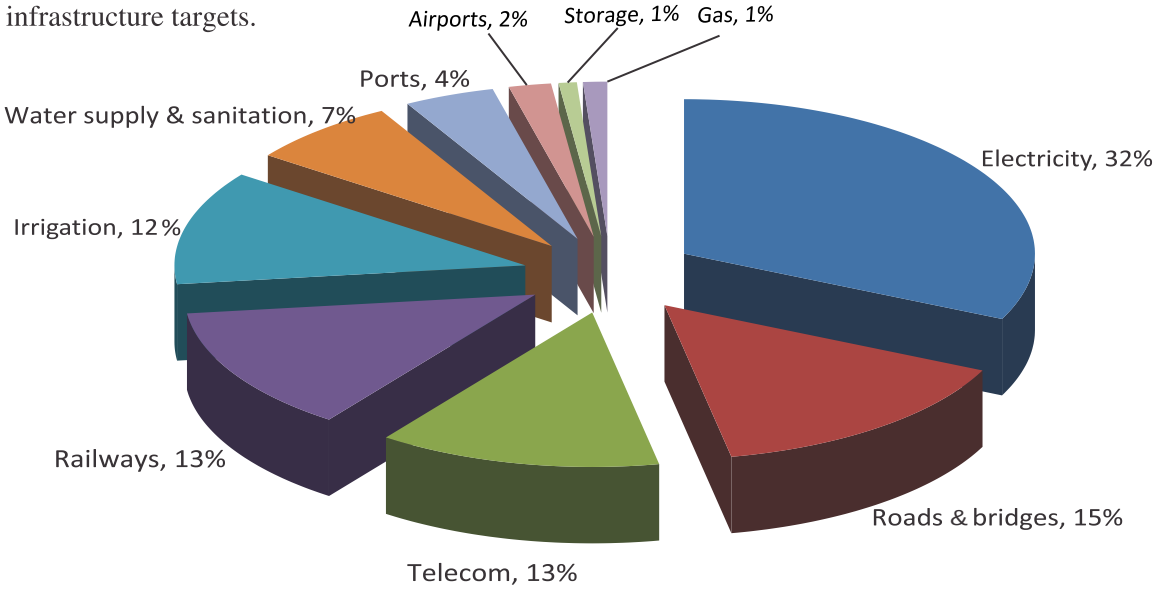


Fig. 2.1 : Infrastructure sectoral investments for XI FYP

Table 2.1 : GCF in infrastructure based on growth targets (Top-down estimates)[5]

(₹. crore at 2006-2007 prices)

XI FYP						
Year	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
GDP (Market prices)	41,45,810	45,18933	49,25,637	53,68,944	58,52,149	63,78,843
Rate of GDP growth (%)	9.00	9.00	9.00	9.00	9.00	9.00
GCF in infrastructure as % of GDP	5.00	5.75	6.50	7.25	8.00	9.00
GCF in infrastructure *(₹.crore)*	207,291	259,839	320,166	389,248	468,172	574,096

Table 2.2 : Infrastructure investment in the XI FYP based on sectoral analysis (Bottom-up estimates)[6]

Sectors	₹. (crores)	Sectoral Shares (%)
Electricity (incl. NCE)	666,525	32.42
Roads and bridges	314,152	15.28
Telecommunications	258,439	12.57
Railways (incl. MRTS)	261,808	12.73
Irrigation (incl. WD)	253,301	12.32
Water supply & sanitation	143,730	6.99
Ports	87,995	4.28
Airports	30,968	1.51
Storage	22.378	1.09
Gas	16,855	0.82

[5] "Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August 2008

[6] "Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August 2008

Table 2.3 : Revised projected investment in the XI FYP as a percentage of GDP[7]

(₹ crore at 2006-2007 prices)

Years	X FYP (Actual)	Base year of XI FYP (2006-07) (Actual)	2007-08 (Actual)	2008-09 (Actual/ Est.)	2009-10 (RE/BE/ Proj.)	2010-11 (BE / Projected)	2011-12 (Projected)	Total XI FYP
GDP at Market prices	1,78,40,877	42,83,979	47,17.187	50,03,545	53,63,800	57,92,904	63,14,265	2,71,91,700
Total Investment	9,06,074	2,44,495	3,03,807	3,59,192	4,02,829	4,60,059	5,28,316	20,54,205

2.3 Physical Performance

While the numbers cited earlier improve confidence in the projections, significant gaps on physical performance need to be plugged in the remaining years of the XI FYP or perhaps added on to the targets for the XII FYP.

For example, in the power sector, capacity addition has consistently fallen below target in successive plans, the average capacity addition achieved being only about half of the target. While there may be many reasons for such a deficit, a major contributor is the manpower deficiency in the engineering sector, particularly in Civil Engineering.

The XI FYP originally envisaged a capacity addition of nearly 78 GW, about 3.5 times more than what was actually added during the X FYP. Ramping up capacity addition, that is, increasing the rate at which additional capacity could be mainlined, takes time and the additional capacity commissioned up to December 31, 2009 was only about 19 GW. The current estimated achievement for the XI FYP is a total of 62 GW, which falls short of the target by about 20%.

The scenario in the power sector is played out, in broad brushes, in the other sectors also. In sectors like transport, roads, railways, ports, physical performance upto date is well short of targets. Such scenarios provide a compelling reason for undertaking detailed plans for manpower assessment, particularly civil engineers for bridging the gaps during the remaining tenure of the XI FYP and achieving the highly ambitious investment target of about ₹ 46,12,500 crores in the XII FYP.

2.4 Looking ahead to XII FYP, 2012-13 to 2016-2017

The most critical aspect of the XII FYP, as of now, is the investment level, at about ₹. 46,12,500 crores. The allocation of this sum amongst the various sectors depends on many factors on which the Government would take a view after a detailed study of current and emerging trends. Hence, any estimate of the Civil Engineering input required for absorbing the projected investment cannot escape from the uncertainties inherent in the composition of the plans.

Such uncertainties pertain to population growth, the mix of economic activities between primary / secondary / and tertiary sectors / sustaining economic growth / prospects of inclusive development including rate of job creation / utilizing the demographic dividend / pace of urbanization / global compacts with regard to climate change concerns / disaster mitigation and many others. However, the general trajectory of infrastructure development would still be pertinent, especially given that physical progress has been lagging vis-à-vis the targets over the past many Plans.

[7] GDP data for 10th plan, 2007-08 & 2008-09 are from Central Statistics Organisation (CSO), GDP growth rates for 2009-10, 2010-11 & 2011-12 have been assumed as 7.2%,8% & 9%

Under this scenario, this Report assumes a conventional break-up of the investment for infrastructure, though there is a quantum jump in the amount. A few changes expected are, inter alia, an increase in the amount for irrigation, given the need to focus on agriculture and also the possible effects of global warming / sharper emphasis on roads, railways and ports / and also on power generation but possibly with significant changes in its composition, vis-a-vis nuclear power generation etc. However, for the task at hand, namely, estimating Civil Engineering inputs, these are unlikely to have a significant effect.

Fig. 2.2 shows the tentative estimates of the sectoral break-up of infrastructure investment in the light of these considerations.

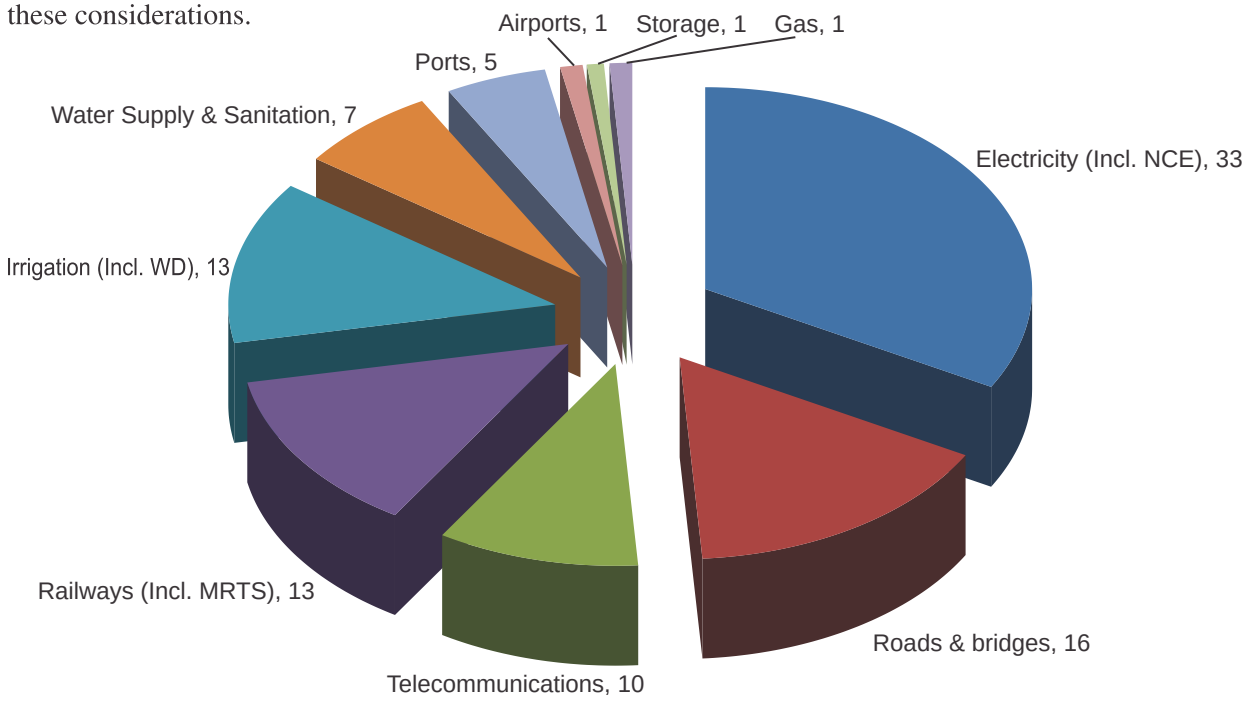


Fig. 2.2 : Estimated infrastructure sectoral investments for XII FYP (in %)

Table 2.4 : Infrastructure investment estimates in the XII FYP[8]

(₹. crore at 2006-2007 prices)

XII FYP						
Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**
GDP (Market prices)	69,52,939	75,78,703	82,60,787	90,04,257	98,14,640	1,06,97,958
Rate of GDP growth (%)	9.00	9.00	9.00	9.00	9.00	9.00
GCF in infrastructure as % of GDP	7.25	7.75	8.25	8.75	9.25	9.75
GCF in infrastructure *(₹. crore)*	5,04,088	5,87,349	6,81,515	7,87,872	9,07,854	10,43,051

[8] "Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August 2008

CHAPTER 3

ROADS & HIGHWAYS

3.1 Background

It is universally acknowledged that physical mobility of people as well as goods promote economic growth and development. Hence expansion of transport infrastructure occupies a prominent position amongst various infrastructure development items. Within India, roads and railways are the two significant modes of transport; inland water transport has a rather limited role because of geographical constraints. While the relative proportions of the road and rail sectors might change marginally, both the sectors will play an important role. Equally importantly, both these sectors require significant inputs from civil engineers. It is for this reason that review of the sector is being taken up first.

3.2 Road Sector and Five Year Plans

The allocation of Plan expenditure on roads went up from about 3% in the IX FYP (1997-2002) to about 15.28% in the XI FYP (Table 2.2), mainly for national highway and rural road development programs. In addition to Government of India, a few State Governments and industry associations have taken initiatives viz. encouraging private sector participation in highway financing, allowing wholly-owned foreign direct investment in the sector, establishing training centers for construction workers, and devising a grading/rating system for construction firms to foster the growth and efficiency of the road construction industry.

In India as elsewhere, the main element of road investment is civil works – typically 95% of the road sector budget. The success of such investments depends on the capacity and capability of the Indian road construction industry. However, even though the magnitude of allocation has risen significantly over the past decade, the capacity to absorb such increased investments has seriously lagged behind, leading to shortfalls in meeting the targets.

This sector competes in the market for skilled manpower with more prominent and booming sectors like ICT and Management, mainly finance. It is facing increasing turnover of its experienced staff and its appeal to fresh talent is decreasing. Further several factors in the investment climate inhibit its operations. Road construction and maintenance has become equipment - and capital-intensive and the capacity constraints on the capital goods front make the going difficult. However, it is still the case that manpower shortage, which is the major focus of this Report, is the most prominent reason for the shortfall the country faces in meeting the targets.

3.3 Investment Plans during the X FYP

The X FYP (2002-07) envisaged balanced development of the total road network in the country. This included phased removal of deficiencies / widening and strengthening / improvement / rehabilitation / and reconstruction of weak or dilapidated bridges / adequate road maintenance, and / road safety measures. It also stressed improvement of the riding quality of the existing national highways and provision of wayside amenities to road users. The National Highway Development Projects (NHDP) Phase I and II were launched. The Pradhan Mantri Gram Sadak Yojana (PMGSY) program for rural roads was initiated and subsequently expanded to achieve the Bharat Nirman target of connecting communities of more than a thousand people (500+ for hilly and tribal areas) with all-weather roads by 2009-10. Investments in Roads and Bridges during the X FYP are shown in Table 3.1.

Table 3.1 : Investments in Roads & Bridges during the X FYP

(in ₹. crores)

Year	2002-03	2003-04	2004-05	2005-06	2006-07	Total
Total	26,605	20,564	21,379	34,278	42,065	1,44,892

3.4 Investment Plans during the XI FYP (2007-08 to 2011-12)

Details of distribution of the projected road sector investment program of ₹. 3,11,152 crores across National Highways (NH) under the NH Development Programme (NHDP) and other NH, State roads (highways, major district roads and other roads), rural roads and the roads in the North East are given at Table 3.2.

Table 3.2 : Projections on Investment in Roads during the XI FYP[9]

(₹. crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
National Highway	23,271	24,698	27,118	32,510	38,257	1,45,853
NHDP Public	10,077	10,513	11,038	12,282	15,233	59,143
Other NH (Public)	1,181	1,273	1,371	1,473	1,572	6,869
NHDP Private	12,012	12,911	14,709	18,755	21,452	79,840
State Roads (Highways, Major District Roads, Others)	21,491	22,431	23,817	26,998	32,215	1,26,952
Public	17,534	18,150	18,889	20,613	24,815	1,00,000
Private	3,957	4,281	4,928	6,385	7,401	26,952
Rural Roads: Bharat Nirman	6,341	6,851	7,276	7,784	8,330	36,582
North East Roads: SARDP	719	809	989	1,079	1,169	4,765
Total	**51,822**	**54,789**	**59,200**	**68,370**	**79,971**	**3,14,152**

One of the physical components envisaged is a core network of about 71,500km including expressways / four-laned roads / strengthened pavements / pavements with good riding quality / bypasses / bridges, etc. with a financial outlay of ₹. 80,000 crore (approx.) covering various states. In such a network based on the 'corridor concept', a commercial vehicle could cover about 500 km in one day (800 km or more on expressways) with adequate road safety. However, the Mid-term Assessment shows that the projected

[9] *"Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August*

investment in road sector over the Plan period is significantly lower at ₹. 2,78,658 crores, a shortfall of nearly 12%. This decline in investment is because of a shortfall in the award of road projects by NHAI during the first three years of the Plan.

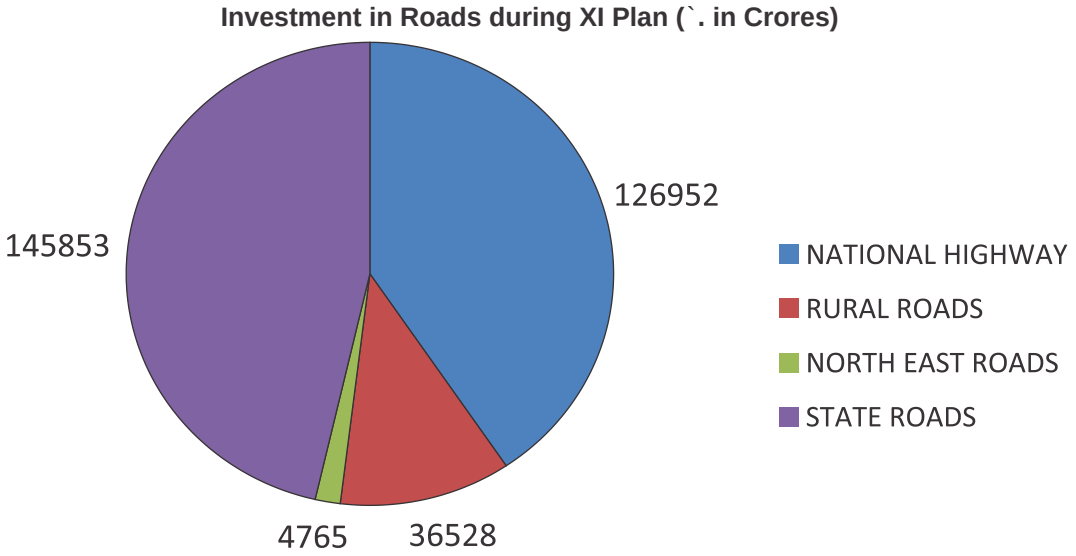


Fig. 3.1 : Projections on Investment in Roads during the XI FYP

By February 2009 only 20 per cent of the projected road length under NHDP had achieved completion and the progress under other programs was unsatisfactory. While efforts are underway to accelerate project execution during the remaining tenure of the XI FYP, it is realistic to assume that large shortfalls will be carried over to the XII FYP and will have to be accommodated therein.

3.5 Projection of Manpower to Meet Future Demand

The road sector investment during the XII FYP is projected at ₹. 7,36,000 crores, 16% of the total investment envisaged. Assuming that about 80% of the investment is translated onto the ground through the efforts of civil engineers, the absorption capacity of the Civil Engineering workforce at the graduate level would be about ₹. 6,45,000 crores (including the carry-overs from XI FYP) up to 2017. This has to be translated into man-years input of civil engineers over the period to estimate the requirements, at the order of magnitude level.

As per estimates, India in 2007 had around 1,10,000 highway engineers (Fig. 3.2) and the revised investments that year is ₹. 42,741 crores. Hence, one Civil Engineering man-year (across the hierarchy of graduate, diploma holders and other technical persons) accounts for an absorption of about ₹. 40,00,000.

Three typical scenarios were considered to make an assessment of demand for workforce for the eight year period from 2007-08 to 2014-15.

Scenario 1: Growth rate extrapolated as per achievements in the years 2000-01 to 2004-05

Scenario 2: Medium growth scenarios as per the vision documents of the National and the State Governments

Scenario 3: High growth scenario incorporating the massive investments in national highways and rural roads announced by GOI

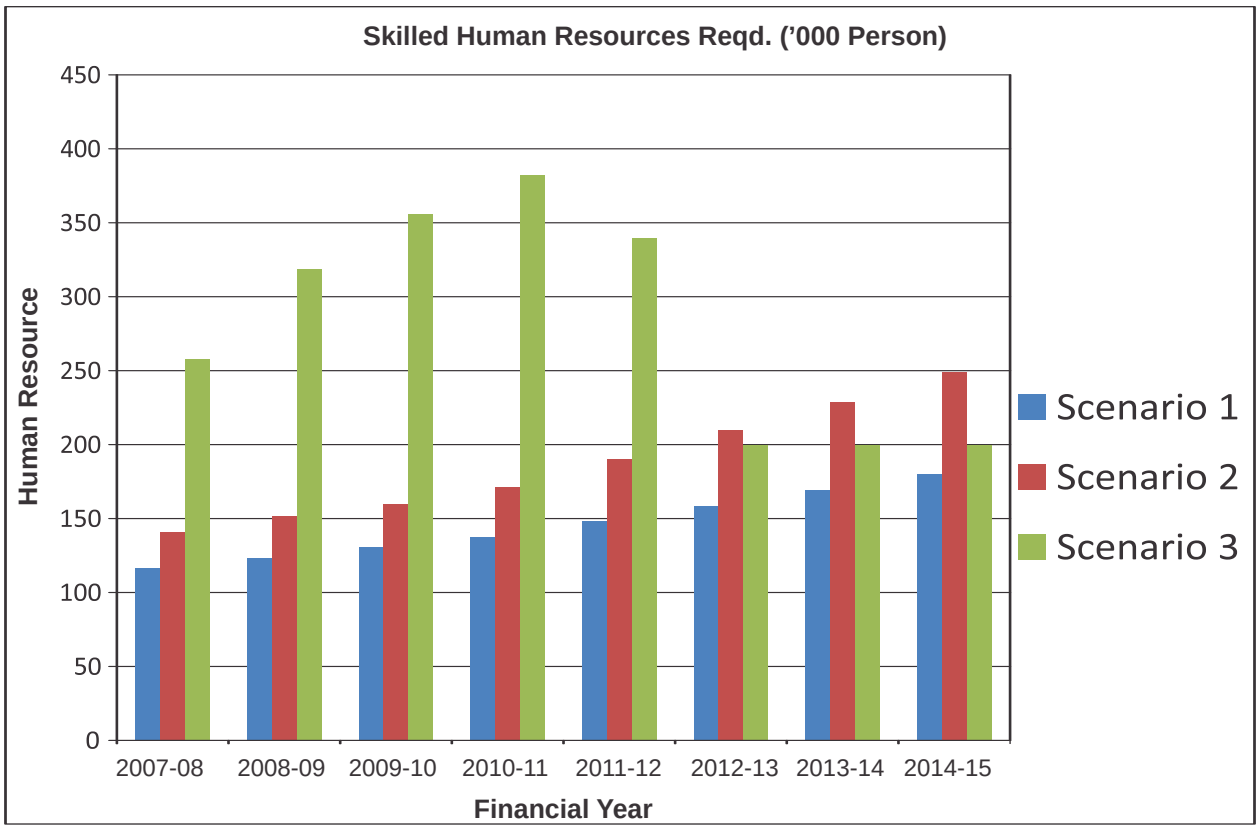


Fig. 3.2 : Projections of Required Highway Engineers

However, it should be noted that these projections were made before the announcement of the XII FYP Investment targets. Hence, the dip witnessed in these figures beyond 2010-2011 is unlikely to be correct and it is more likely that the curve would become more steep.

Table 3.3 : Projections of Required Highway Engineers ('000 persons)[10]

Year	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Scenario 1	116.5	123.5	130.5	137.5	148	158.5	169	180
Scenario 2	141	152	160	171.5	190.5	210	229	249
Scenario 3	258	319	356	382	339.5	200	200	200

Table 3.4 includes the full range of skilled staff from engineers to surveyors and operators. It is observed that the annual average skilled staff requirement under Scenario 2 will be about 2,00,000; under Scenario 3 the annual average requirement, during the peak demand period of 2009-2012, will be a massive 3,30,000.

[10] Report on "Indian Road Construction Industry", Nov,2008

This would represent an increase of about 30% and 120% respectively from Scenario 1.

Table 3.4 : Peak annual requirements (average over 2007-12)[11]

Skilled HR required -annual average	Scenario 1	Scenario 2	Scenario 3
Total (approx.)	1,50,000	2,00,000	3,30,000

It is observed that the numbers of skilled and semi-skilled persons working in the road sector are still growing at a moderate pace and would only be able to cope with Scenario 1. Surveys show that the number of such manpower working in the road sector at present is about 110,000.

• Data analysis and some realistic assumptions suggest that at present about 6,000-7,000 fresh civil engineers and diploma holders are joining the road sector workforce (replacing retirees from the sector)

• But this is not sufficient even to meet the annual increased requirements of 7,500-10,000 skilled personnel under Scenario 1 over the next eight years

• Under Scenario 2 this annual requirement increases from a minimum of 10,000 to about 20,000 over the next eight years The additional annual average requirement of such persons at diploma level and above, could be about 50,000 over the period 2007-15

• The annual average peak requirement of such skilled persons increases to about 3,30,000 during the next FYP

• The annual increase under Scenario 3 increases from a minimum of about 25,000 to a maximum of about 60,000

Estimates as given in Annex 3/1 support the above assessment.

3.6 Summary

The supply of civil engineers is woefully inadequate to meet the rising demand of the road infrastructure sector. This is one of the major contributory reasons for the continuing / and ever increasing shortfalls between the targets and actual achievements as well as the delays in completion of projects. The scenario is bound to worsen given the quantum jump in the investment in this Sector during the XII and the subsequent Plan periods. The peak enhancement is estimated at 49,000 for the projected investments till 2017.

[11] Report on “Indian Road Construction Industry”, Nov, 2008

Annex 3/1

Roads & Highways

This Annex presents the details regarding the Civil Engineering manpower requirements in Chapter 3 – Roads and Highways.

The investments in this sector during the XI FYP are given at Table 3/1-1.

Table 3/1-1 : Investment in Roads &Highways Sector (XI FYP)

(In ₹.crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Centre	30,330	32,357	35,382	41,373	47,756	1,87,199
Public	18,318	19,446	20,673	22,618	26,304	1,07,359
Private	12,012	12,911	14,709	18,755	21,452	79,840
States	21,491	22,431	23,817	26,998	32,216	1,26,952
Public	17,534	18,150	18,889	20,613	24,815	1,00,000
Private	3,957	4,281	4,928	6,385	7,401	26,952
Total	**51,822**	**54,789**	**59,200**	**68,371**	**79,971**	**3,14,152**
Revised Total	**42,741**	**48,108**	**54,638**	**63,183**	**69,988**	**2,78,658**

The manpower input for such a large investment has been estimated broadly in line with the methodology adopted for other sectors. It is stressed this is a rough estimate in an overall perspective, supplemented by relevant data based on on-going project numbers and not on rigorous mathematical and statistical analysis. A few relevant details are as under:

1. NH-7 Hyderabad – Bangalore under NHDP. The 125 km long project stretch is scheduled to be completed within 30 months at a cost of ₹. 555 crores. The Civil Engineering manpower input for 125 km, at the level of graduate engineers including the consultants' supervisory staff, contractors and the like, is determined as 132 and the total manyear input, 330.
2. In a construction supervision project – namely Haldia Port connectivity along NH-41 - for a stretch of 36 km to be executed over 30 months, Civil Engineering input was of the order of 60 engineers and the manyear input was pegged at 150. The cost of the project was ₹. 300 crores.
3. Lucknow–Muzaffarpur Construction Supervision Project covered 118 km over 5 years. The cost of the project was ₹. 900 crores, involving a total of 79 civil engineers and 400 man years (approx.).

It may be noted that in the projects considered, the emphasis is on the execution stage. Frontend activities like planning, alignment, DPR preparation, tendering etc. have not been accounted for. Hence, it may be appropriate to add a premium of about 5% to the estimated requirements. On these considerations, the total manpower input covering the above projects is reckoned at 285 per year for an annual investment of about ₹. 525 crores. In other words, one graduate civil engineer will be required to execute works worth ₹. 2 crores per year.

Recognizing that about ₹. 70,000 crores is the Plan expenditure (revised) in the last year of the XI FYP and the outlay during the XII FYP would be nearly twice that of the XI FYP, the total investment to be absorbed by 2017 comes to about ₹. 8,08,000 crores. Assuming 80% absorption is through Civil Engineering, this translates to about ₹. 108,000 crores per year between 2011 and 2017.

The peak annual enhancement may be of the order of about 49,000.

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table : 3/2-1

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Inv. Plan (₹. Crores)	70,000	80,000	100,800	130,032	161,240	192,128
% increase		14	26	29	24	19
Manpower ('000)	119*	135	168	215	264	311
Manpower Increase (Y-on-Y)		16	33	47	49	47
% increase		13.45	24.44	27.98	22.79	17.8

Note: * - Projected to 2011 from an estimated 110,000 in 2007, at 2% CAGR

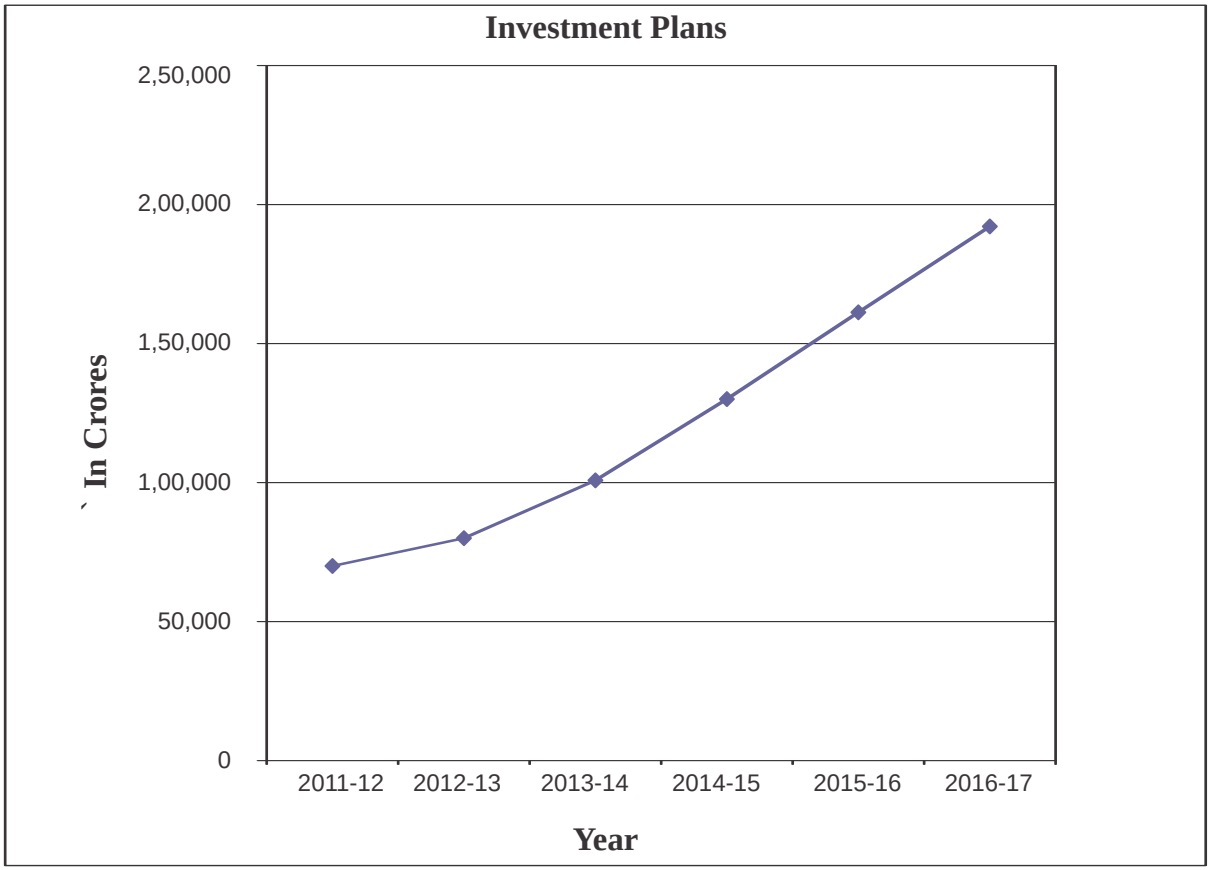


Fig. 3/2-1

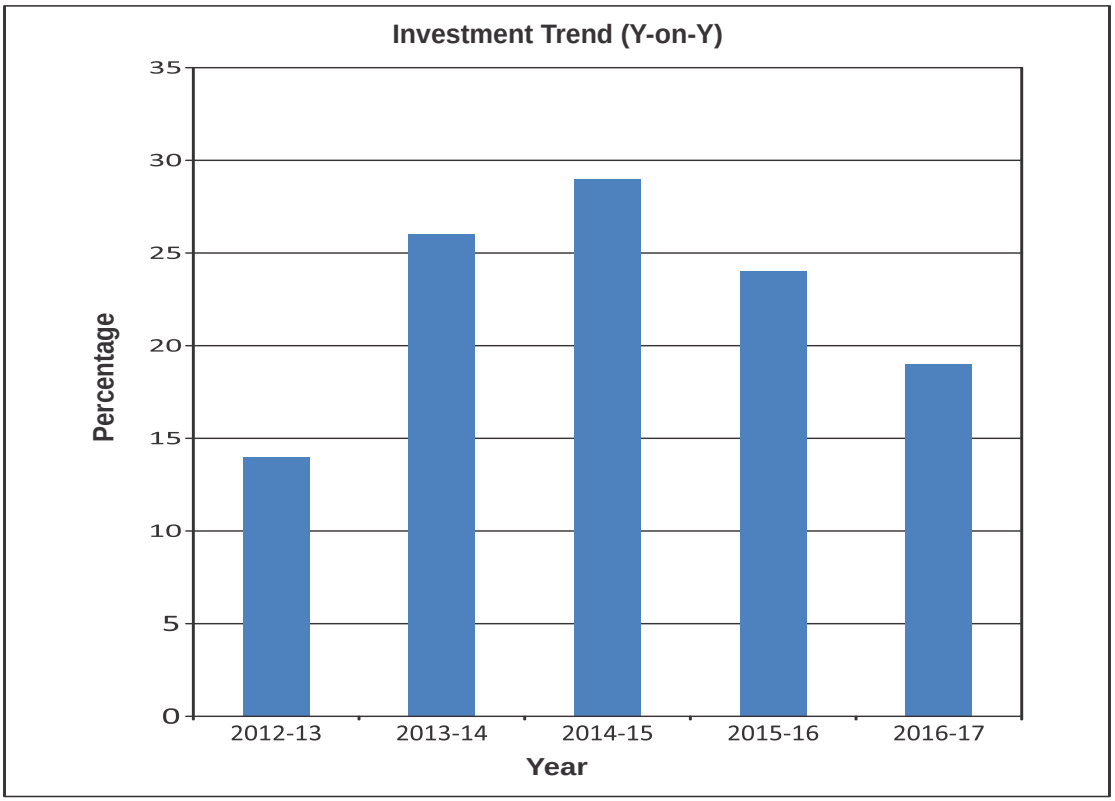


Fig. 3/2-2

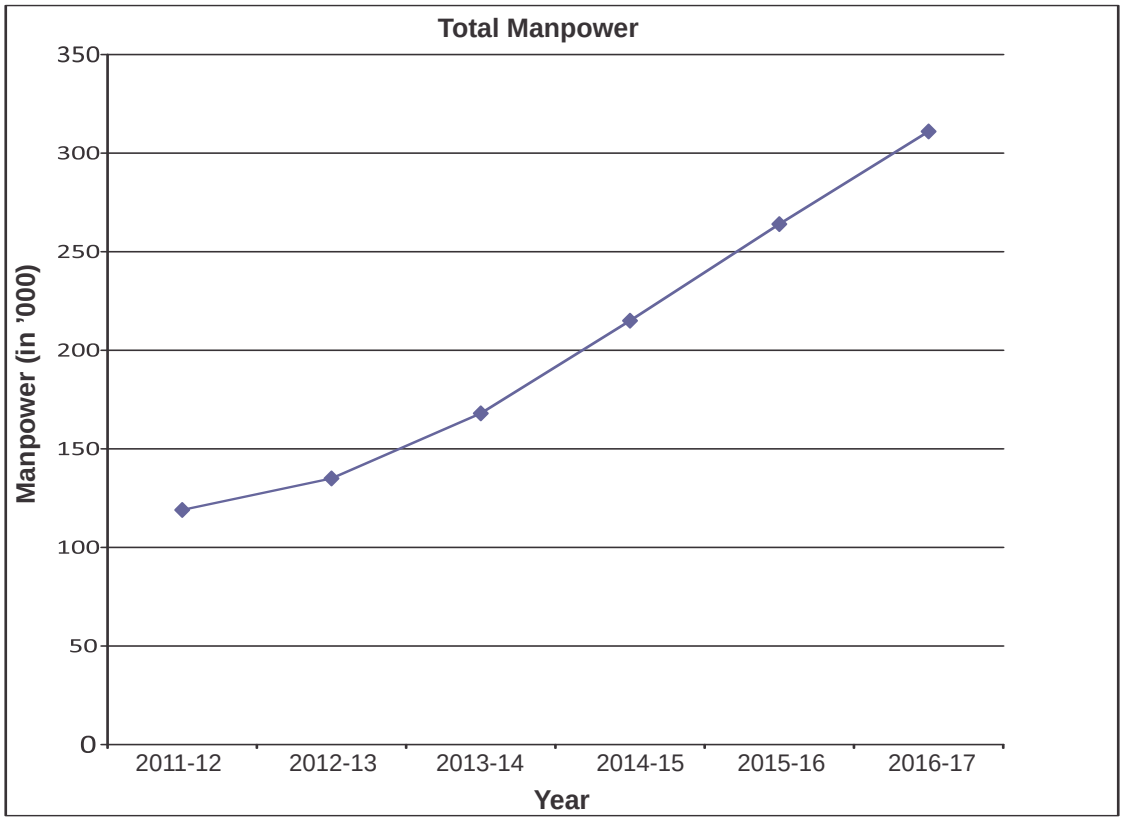


Fig. 3/2-3

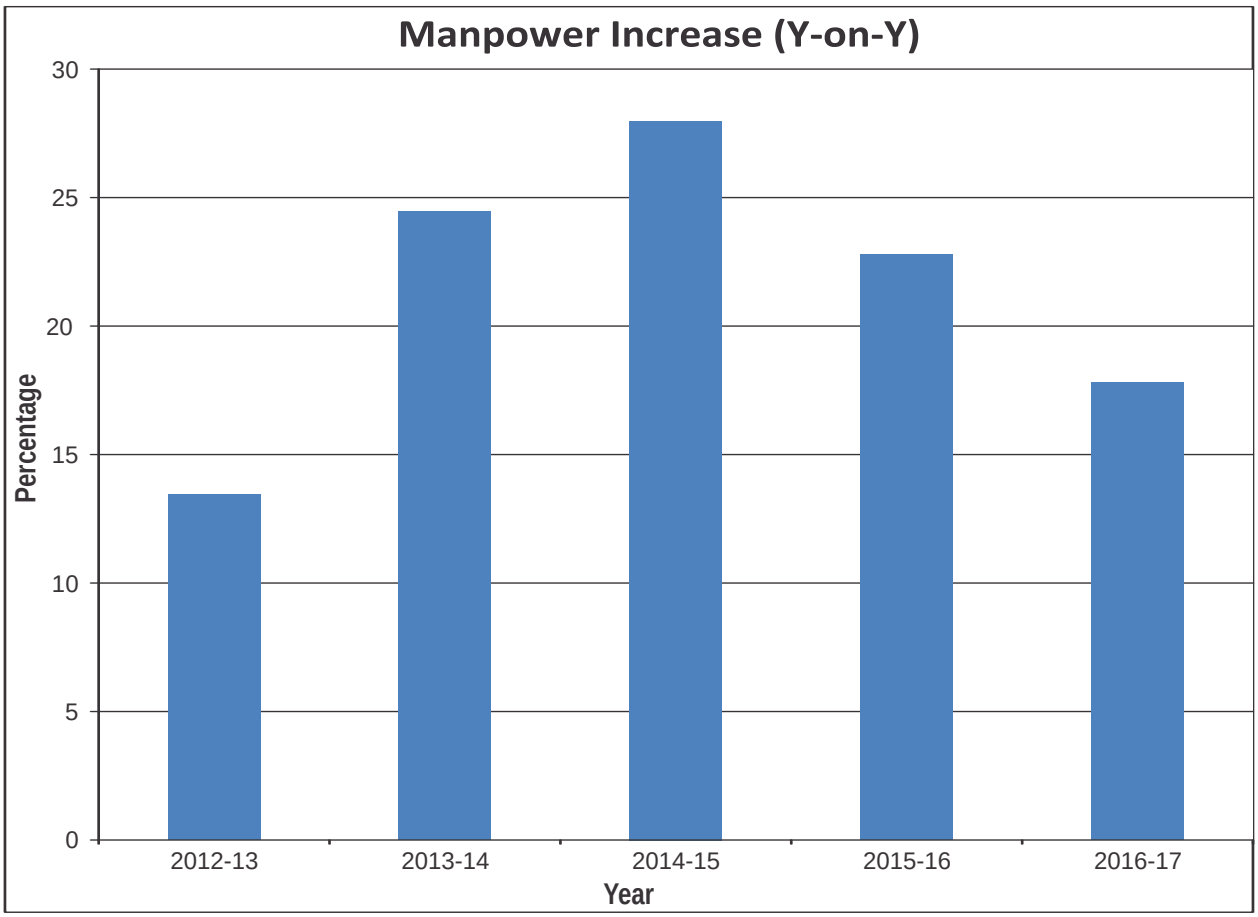

Manpower Increase (Y-on-Y)
30
25
20
15
10
5
0
Percentage
2012-13
2013-14
2014-15
2015-16
2016-17
Year

Fig. 3/2-4

CHAPTER 4

RAILWAYS

4.1 Background

The railway serves the economy by moving people as well as commodities and contributes towards inclusive development by promoting access to remote areas - a double mandate. Indian Railways - one of the largest employers in the country has a focus on bulk goods transport like ore, coal. However, the proportion of freight carried by it has steadily come down and has shifted in favour of the road sector.

Looking to the future, in the context of the current emphasis on resource conservation and global warming issues, the energy efficiency of rail transport will gain prominence. In this scenario, it is extremely likely that rail sector would flourish through retrofitting, setting up new lines, adopting new technologies etc. necessitating much higher levels of Civil Engineering inputs in developing, operating and maintaining such initiatives.

The double mandate of the Indian Railways, mentioned earlier, have led to certain inefficiencies, particularly the cross-subsidy between freight movement and passenger transport. The current efforts for more efficient operations involve introduction of new technology, mobilization of resources from the markets etc. and would hopefully lead to system improvements and highlight the requirement of engineering professionals, particularly for timely project implementation. Further, the railways need an urgent effort to improve the capacity, quality and safety of its services, a Civil Engineering intensive effort.

4.2 Review of Progress during the X FYP

The Railways had projected a Plan outlay of ₹. 64,687 crores for the X FYP, with a budgetary support of ₹.40,615 crores including a contribution to Special Railway Safety Fund (SRSF) amounting to ₹.10,965 crores. The Plan was approved with an outlay of ₹. 60,600 crores including budgetary support of ₹.27,600 crores. The outlay achieved during the Plan period was ₹. 84,708 crores (approx.) and the unfinished projects were carried over to the XI FYP.

4.3 Review of Progress during the XI FYP– Mid-term Assessment

Against a projected investment during the XI FYP of ₹. 2,61,808 crores the approved outlay is ₹. 1,94,263 crores (at constant 2006-07 prices), including, General Budget Support (GBS) for ₹. 44,263 crores (excluding funds for National Projects) as well as Internal and Extra-Budgetary Resources (IEBR) for ₹.1,50,000 crores.

During the first four year of the XI FYP, Indian Railways is likely to spend ₹.1,28,604 crores at constant prices, (including ₹. 43,658. crores as GBS), viz, about 66 percent of the outlay. This will certainly lead to large shortfalls in realization of Plan targets, which would have be carried over to the next Plan period.

The nature of the infrastructure projects identified in the XI FYP involves mainly civil works like strengthening of high density network, augmentation of terminal capacity by developing / modernizing freight terminals, developing private freight terminals, setting up world-class stations as well as developing infrastructure projects for port connectivity. Technological upgrade and modernization are some of the areas which deserve much more attention from the Railways.

Table 4.1 : Projected Investment in Railways during the XI FYP[12]

(₹. In Crores)

Rolling Stock	**45,729**
Capacity augmentation and development	58,870
Safety and other works	95,129
Investment in PSUs	9,390
Dedicated freight corridors	25,500
Metro Rail Transport System (MRTS)	27,191
TOTAL	**2,61,809**

The proposed outlay on various infrastructure development programmes of the Indian Railways during the XI FYP is around ₹. 2,55,000 crores. This envisages augmentation and modernization of railway infrastructure including:

• Provision of ₹. 10,000 crores for High Speed Passenger Corridors (for speeds of 300 to 350 kmph) – one each in Northern, Western, Southern and the Eastern Region

• An outlay of ₹. 28,000 crores on the Eastern & Western Dedicated Freight Corridor Project (DFC). Dedicated Freight Corridors are strategic capacity augmentation initiatives involving construction of about 3,300 kms of dedicated freight lines primarily to carry coal and steel on the Eastern corridor and containers on the Western corridor. Ports in the Western region covering Maharashtra and Gujarat would be efficiently linked to the Northern hinterland. Similarly on the Eastern side, coal would move to the power plants in the North

• ₹. 55,000 crores on other Dedicated Freight Corridors

• ₹. 2,700 crores for modernization of 10 workshops

• ₹. 4,750 crores for Metropolitan Transport Projects (excluding the Mumbai Urban

Transport Project (MUTP) Phase – II in Mumbai)

• Port connectivity projects with an outlay of ₹. 3,800 crores

• Electrification & Electrical Works amounting to ₹. 7,000 crores

• Completion of work of 4,900 kms of gauge conversion, 1,800 kms of doubling as well as laying 1,100 kms of new lines, over five years

• Investments towards expansion of the Railway Network in Jammu & Kashmir as well as Gauge Conversion and other Railways Projects in the Northeast

• Developing 23 world class stations with 4 (including New Delhi) in the first phase; approximate modernization cost of each would be in the region of ₹. 5,000 crores

• Upgrading 300 other railway stations to become model stations.

[12] "Projections of investment in Infrastructure during the XI FYP", Planning Commission, GOI, 14th August

As of April 1, 2010 Indian Railways had 327 ongoing projects for new lines, gauge conversions and doublings, involving an investment of about ₹. 98,000 crores. Of the 378 'Adarsh' stations identified, 315 have been developed so far. Of the 67 stations identified for the development of multi-functional complexes during 2009-10, construction work has been taken up for 27. Construction of flyovers, bypasses, Intermediate Block System (IBS), upgrading goods shed etc., traffic facilities works will be completed on priority.

4.4 XII FYP (2017) and Looking Beyond

The Vision Document 2020 for Indian Railways envisages an investment of ₹. 14,00,000 crores (approx.) up to 2020. Also, 2,500-3,000 kms of high speed passenger dedicated rail lines would have to be planned and built in the next ten years.

Other Infrastructure investments proposed to be made by Indian Railways are:

• Wheel Manufacturing Plant at Chhapra (Cost ₹ 1,200 cr. approx.)

• New Rail Coach Factory at Rae Bareli (Cost ₹ 1,700 cr. approx.)

• New Diesel Locomotive Production Unit at Marhoura (Cost ₹ 1,500 cr. approx.)

• New Electric Locomotive Production Unit at Madhepura (Cost ₹ 1,500 cr. approx.)

These would be in addition to the XI FYP projects be carried forward for completion in the XII FYP.

The total additional workforce required in the next 10 years to realize the Plan targets is estimated at 44,00,000. The annual enhancement may reach a peak of 8,000.

4.5 Mass Rapid Rail Transit System

Given the reality of rapid urbanization, the National Urban Transport Policy (NUTP) has focused on, inter alia, rail based urban mobility. Over the next 5 years, a total investment of ₹. 61,900 crores is expected in the MRTS segment, of which the construction part would be around ₹. 26,000 crores, and civil works would account for 42%. In the period up to 2020, total investment of ₹. 2,14,300 crores is expected.

It is estimated that more than ₹. 50,000 crores would have been invested on metro rail projects by the end of the XI FYP period against a projected investment of ₹. 27,191 crores on MRTS. Further, metro rail projects may need as much as ₹. 1,00,000 crores over the next ten years. All these considerations have to be taken into account in assessing the number of Civil Engineering manpower input required over this period. An indication is that the 71km long metro rail project in Hyderabad costing ₹. 12,132 crores would generate employment for about 5,000 engineers and about 45,000 skilled and unskilled workers.

4.6 Manpower (Civil Engineers) requirement for the next 10 years

In the next 10 years MRTS would require an investment of ₹. 2,14,300 crores of which the requirement for civil works for infrastructure development would be ₹. 75,000 crores, (35%). It is estimated that an investment of ₹.75,000 crores only in civil works, would require 25,000 number of Civil Engineers up until 2020.

Annex 4/1

Railways

This Annex presents data regarding the Civil Engineering manpower requirements in Railways. Projected investment in railways (XI FYP) is given in Table 4/1-1 below.

Table 4/1-1 : Investment in Railways (XI FYP)

(in ₹. crores)

Rolling Stock	**45,729**
Capacity augmentation and development	58,870
Safety and other works	95,129
Investment in PSUs	9,390
Dedicated freight corridors	25,500
Metro Rail Transport System (MRTS)	27,191
TOTAL	**2,61,809**
Revised Total	**2,00,802**

The current workforce in the railways is more than 33,45,000, out of which Civil Engineering accounts for about 12,000 or 0.35%.

While this is correct for railways as a whole, the increased pace of planning for and executing metro systems in all the major cities and many other cities presents an opportunity for another look at the size of the Civil Engineering work force.

For Kolkata East-West metro, it is estimated that a total investment of nearly ₹. 5,000 crores over 5 years, would require about 200 civil engineers for the full duration, namely 1,000 Civil Engineering man years.

The XI FYP outlay for MRTS across the country is pegged at ₹. 27,191 crores. In view of rapid urbanization, it is likely that during the XII FYP, the outlay would increase to about ₹. 60,000 crores, requiring 12,000 Civil Engineering manyears. In other words, a requirement of 2,400 civil engineers exclusively for metro systems up to 2017. We may double the same as an estimate up to Year 2022 namely 5,000 civil engineers for metro rail.

Indian Railways Vision Document, envisages, an investment level of ₹. 14,00,000 crores by 2020. The required manpower augmentation between now and 2022 is estimated at 44,00,000, indicating an increase of 130%. As Indian Railways is keen on technology upgrade, it is likely that civil engineers, with their expertise in GIS and other relevant advanced technologies, will have a higher share, implying an addition of 27,000 during XII FYP.

Annex 4/2

Railways

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table : 4/2-1

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Inv. Plan (₹. Crores)	64,400	78,000	95,000	120,000	153,000	190,000
% increase		21.12	21.79	26.32	27.5	24.18
Manpower ('000)	14	17	21	26	33	41
Manpower Increase (Y-on-Y)		3	4	5	7	8
% increase		21.43	23.53	23.81	26.92	24.24

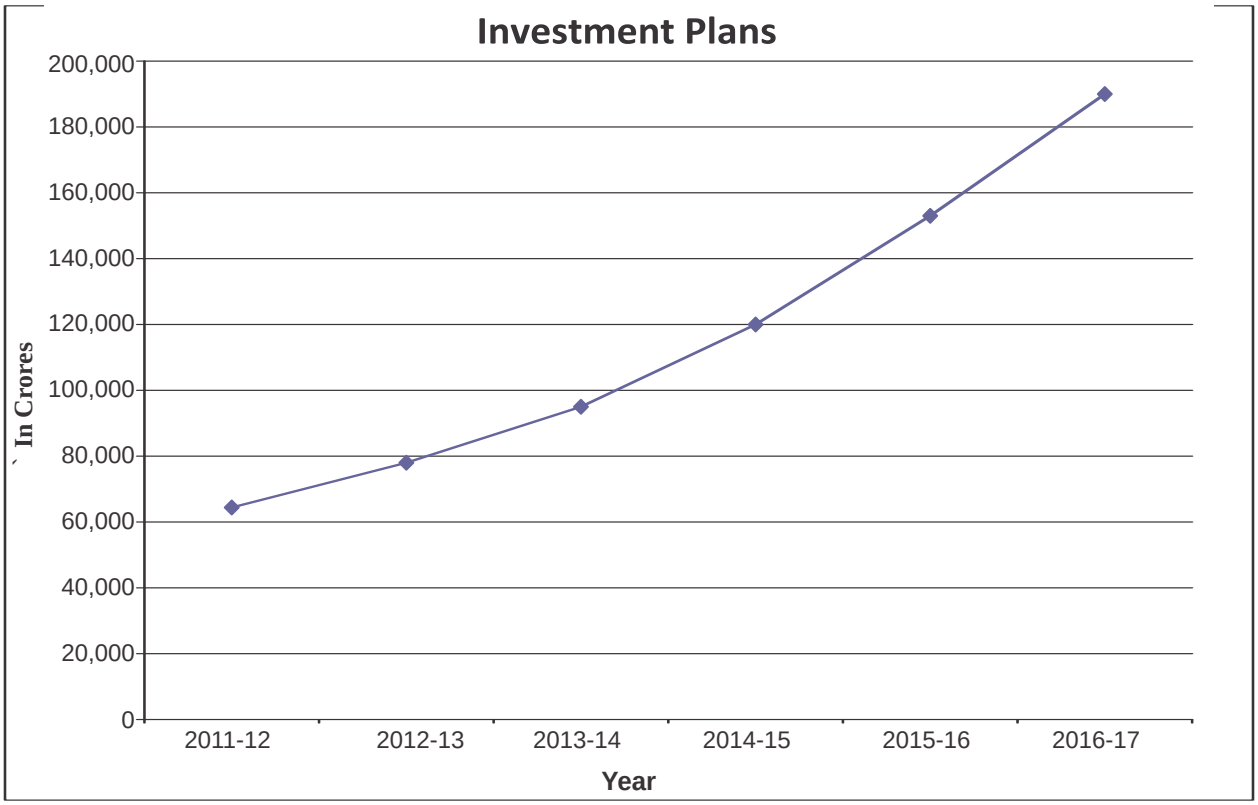


Fig. 4/2-1

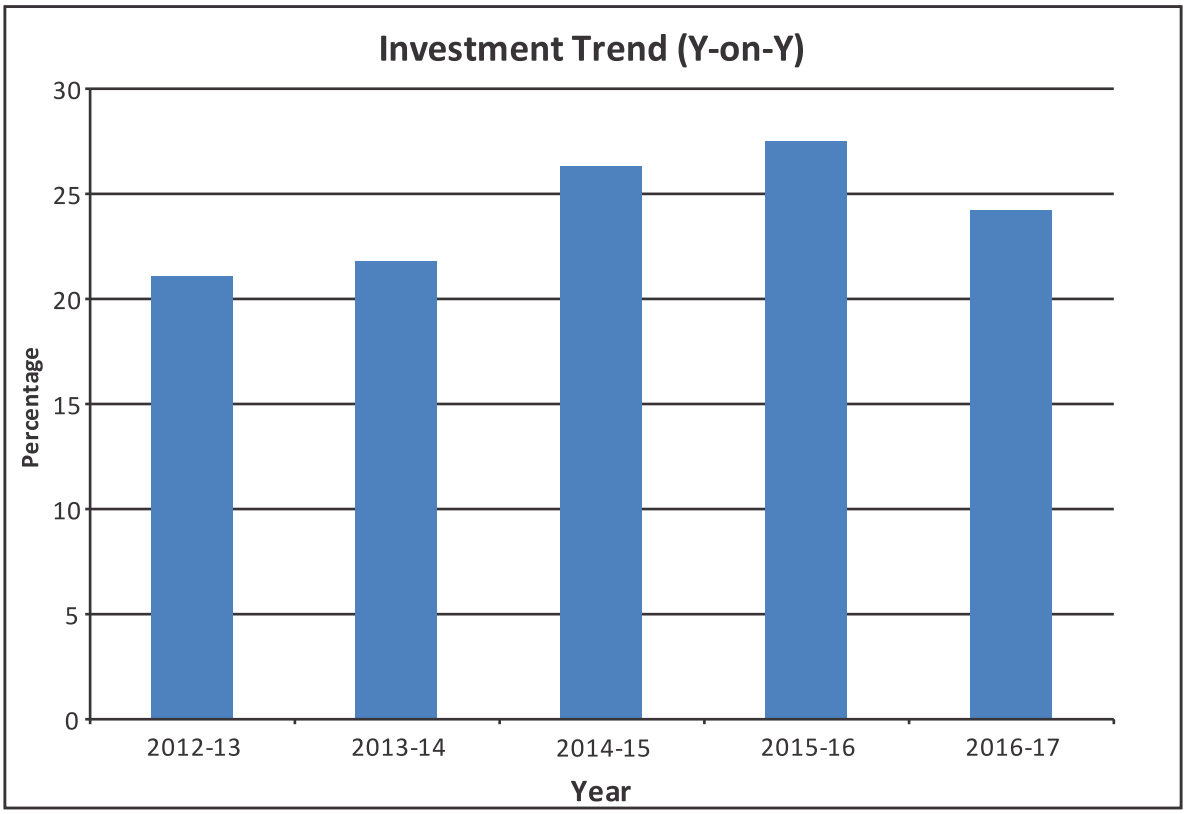


Fig. 4/2-2

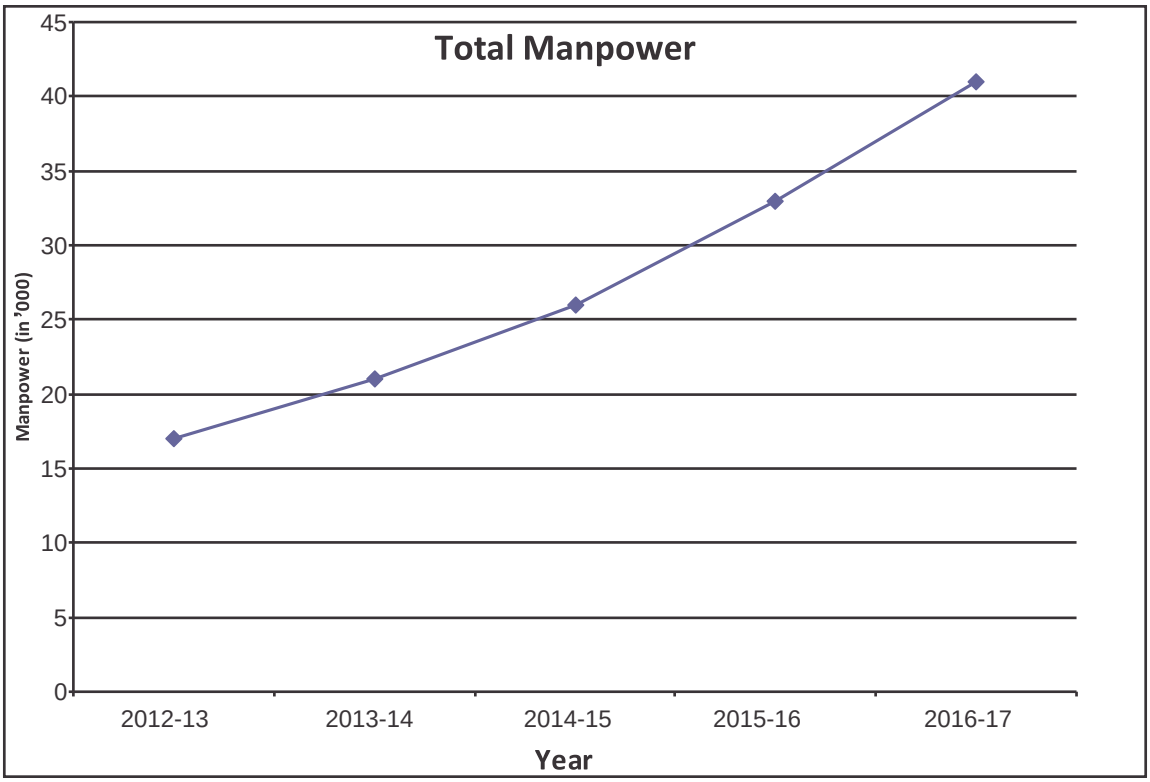


Fig. 4/2-3

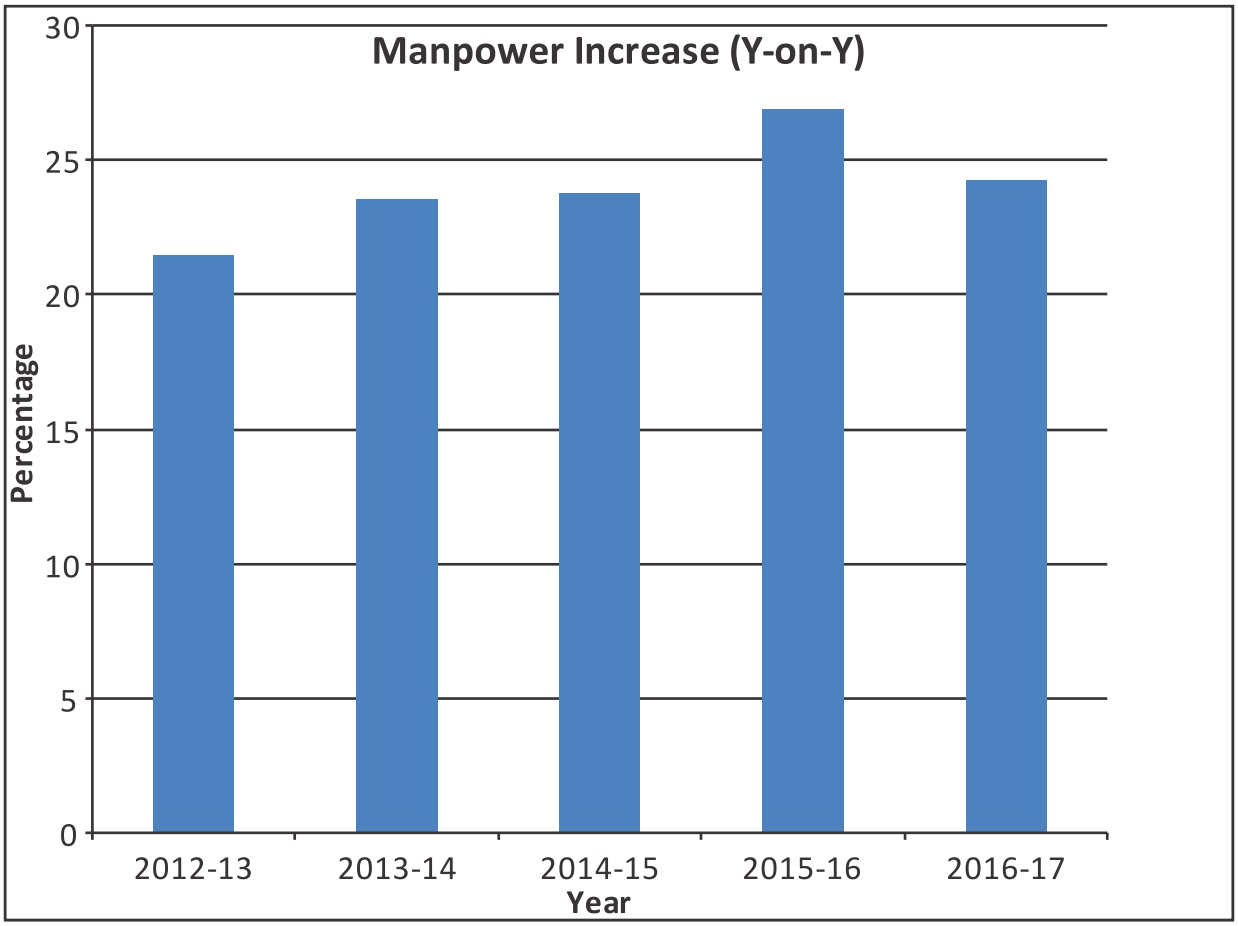

Manpower Increase (Y-on-Y)
Percentage
30
25
20
15
10
5
0
2012-13
2013-14
2014-15
2015-16
2016-17
Year

Fig. 4/2-4

CHAPTER 5

AIRPORT SECTOR

5.1 Background

Civil Aviation, the fastest growing arm (though from a smaller base) of India's transport infrastructure, is playing an increasingly important role in providing both domestic and international connectivity. In 2000-01, India sported an aviation demand profile of 4.2 crores domestic and international passengers and 8,46,420 tonnes of cargo across all the airports in the country. This was considered a not very bright profile, for a population of more than 100 crores and a growing economy with global linkages. However significant improvements have taken place since then as given in the following sections.

5.2 Performance of the Aviation Sector

Table 5.1 shows the performance of this sector till January 2010.

Table 5.1 : Indian Aviation Sector Growth Pattern[13]

Sector	Achievement (April 2008-Jan 2009)	Growth % (April 2008-Jan 2009)	Achievement (April 2009-Jan 2010)	Growth % (April 2009-Jan 2010)
Export Cargo handled (tonnes)	4,45,006	5.0	4,81,576	8.2
Import Cargo handled (tonnes)	3,64,496	-3.5	3,74,881	2.8
Passengers handled at international airports ('000)	18399	5.3	19220	4.5
Passengers handled at domestic airports (₹000)	35869	-12.0	40982	14.3

5.3 Export and Import Cargo

Five International Airports handled 481,576 tonnes of export cargo during April 2009 – January 2010, which was 8.2% higher than the corresponding period of the previous year and higher than the growth rate of 5.0% in April 2008 - January 2009. Further, 374,881 tonnes of import cargo was handled at these airports during this period registering a growth of 2.8%. A negative growth of 3.5% was the outcome during April 2008 - January 2009.

5.4 Passengers Handled

During April 2009 - January 2010, international terminals of the five major International Airports handled 192,22,000 lakh passengers and registered a growth of 4.5% over the numbers during April 2008 - January 2009. The growth rate was lower than the growth of 5.3% achieved in April 2008 - January 2009. The domestic terminals handled 409,82,000 passengers during this period, which was 14.3% higher than the numbers for the corresponding period of the previous year. There was a negative growth of 12.0% during April 2008 - January 2009.

[13] Report on Infrastructure sector performance (April 2009-January 2010), Ministry of Statistics and Programme

5.5 Projections

The projections for growth of both passenger and cargo traffic together with the continuing deficiencies in the airports and allied infrastructure emphasize the urgent need to build and augment aviation infrastructure. It is estimated that the Indian aviation industry will handle more than 30 crores passengers per annum by 2020.

Such projections are in tune with global trends in logistics as well as the performance of various service sectors like tourism, the share of which in the economy is continuously increasing. Aviation provides a fast and reliable mode of transport across the country and is particularly important for many areas / places not yet adequately connected by rail or road. The increasing trend towards globalization will enable this sector to play a significant role in integrating the Indian economy with the rest of the world.

Infrastructure in aviation has many components – the airports themselves and also city-side developments. In particular, the concept of aerotropolises tries to seamlessly blend the ground based urban environment with the flying environment. Such expanding scopes, including of course, the airport proper, gives a fresh impetus and opportunity to Civil Engineering input.

5.6 Investment Plans in the XI FYP

In the X FYP the aim was to provide world class infrastructure facilities for promoting efficient, safe and reliable air services for domestic and international transit including trade and tourism. Meeting the air transport requirements of remote and inaccessible areas was also a priority.

The sector has broadly three distinct functional entities, namely regulatory-cum-developmental, operational and infrastructural. As the sector is set to grow at a rapid pace, airport infrastructure buildings would require a huge number of competent civil engineers.

The airport infrastructure upgrade plan for the XI FYP envisages an investment of ₹. 31,000 crores by 2012 (the end of the XI FYP), covering inter alia, development of 37 non-metro airports (including Sikkim and Arunachal Pradesh airports), Green Field airports and airports in the North-East Region. The Airport Authority of India would develop these 37 non-metro airports through various formats, including PPP modalities. Development of airport infrastructure would include metro, non-metro, Greenfield airports and cargo hubs that are currently under construction or have been sanctioned.

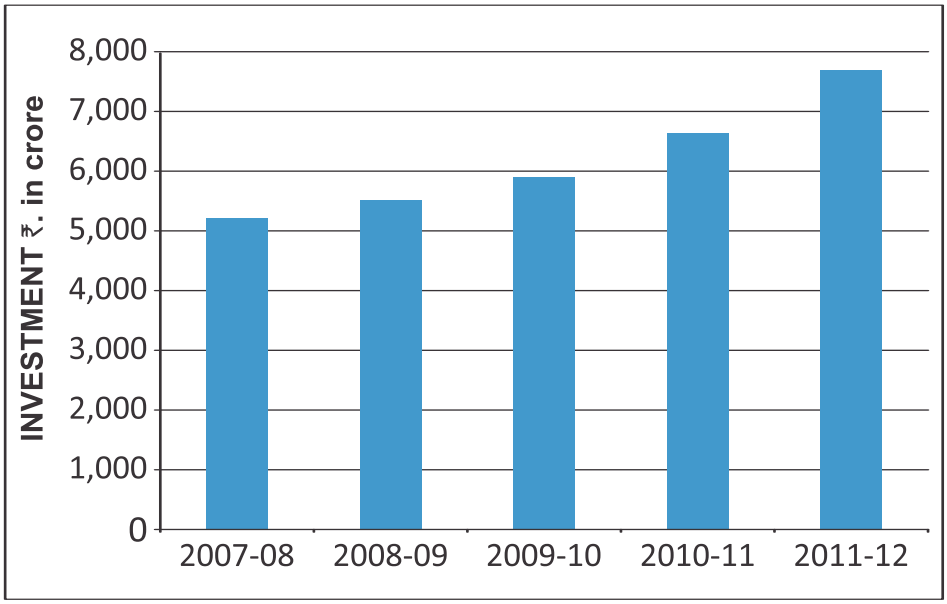


Fig. 5.1 : Investment Plans during the XI FYP

It is important to disaggregate the numbers given in Fig. 5.1. This is presented in Table 5.2

Table 5.2 : Detailed Investment Plans during the XI FYP[14]

(₹. in crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total
Metro Airports	2,758	2,752	2,650	2,520	2,416	13,097
Non-Metro Airports	701	736	830	915	1,039	4,220
Greenfield Airports	1,366	1,539	1,834	2,508	3,327	10,573
NE Airports	85	94	103	113	124	519
CNS-ATM and Equipment	298	400	487	591	785	2,559
Total	**5,208**	**5,520**	**5,904**	**6,646**	**7,690**	**30,968**

Some of the projects under execution / in the pipeline are:

• Modernization and expansion of Netaji Subhash Chandra Bose International Airport at Kolkata and the Anna International airport at Chennai for ₹. 5,700 crores

• 2 Greenfield airports in Bangalore and Hyderabad (₹. 1,300 crore each)

• Development of 37 new non-metro airports

• Upgrading Mumbai and Delhi airports at an estimated investment of ₹.16,000 crores

• Operationalisation by June 2013 of GPS aided Geo-Augmented Navigation (GAGAN), developed by AAI in collaboration with ISRO at a cost of ₹. 774 crores

Table 5.3 : Projected Public-Private Investments during the XI FYP[15]

(in ₹. crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Public	1,196	1,369	1,894	2,205	2,674	**9,338**
Private	4,012	4,151	4,010	4,441	5,016	**21,630**
Total	**5,208**	**5,520**	**5,904**	**6,646**	**7,690**	**30,968**

Investment projected to upgrade existing airports and build new ones to meet the anticipated rise in passenger traffic is ₹. 1,350 crores including the ₹. 405 crores already identified.

[14] "Projections of investment in Infrastructure during the 11th FYP", Planning Commission, GOI, 14th August 2008
[15] "Projections of investment in Infrastructure during the 11th FYP", Planning Commission, GOI, 14th August 2008

Immense improvisation and rapid expansion in Indian airport infrastructure coupled with active Government support for private participants, particularly in Greenfield projects, have enabled the sector to take huge strides forward. The growth forecast for 2009-2013 for international / domestic aircraft movement is 13% and 14% respectively. Domestic / International passenger growth is expected to be 20% and 16% respectively. Domestic and international cargo growth is projected at 12% and 10% respectively.

By 2020, Indian airports are estimated to handle 10 crore passengers, including 6 crore domestic passengers and 340 lakh tones of cargo per annum. This requires massive investments in airport infrastructure to modernize/restructure the existing airports create new Greenfield airports where there is scope and upgrade certain selected airports.

Investments in XII FYP may be nominally projected at ₹. 60,000 crores.

5.7 Projection of Manpower to Meet Future Demand

India's Civil Aviation Ministry expects 8 crore passengers by 2020. The number of air travelers increased by a record 38.5% between 2006 and 2007. India anticipates doubling of passenger traffic over the next decade. Of the 1,000 aircraft ordered at the Paris Airshow, 400 were booked by Air India. To meet the projected addition of about 400 aircraft, India would require about 4,000 pilots, 3,000 engineers, a minimum of 8,000 cabin crew and about 100,000 support staff. All of them would need specialised training.

The total number of pilots, engineers and cabin crew (operational staff) is projected to grow from 32,000 in 2009 to just over 90,000 by 2020. Assuming that the total workforce of private carriers is two times that of the operational staff (pilots, engineers and cabin crew), total employment in airlines would increase from 64,000 to 180,000 as per estimates of the Centre for Asia Pacific Aviation (CAPA). Projections for the next 10 years are based on assumption that the domestic market would grow by more than four fold from what it is now.

Table 5.4 : Assessment of Requirement of Civil Engineers –Upcoming projects[16]

	Modernisation	Greenfield	Upgrade	Improvement	Total
No. of Projects	4	14	25	55	**98**
Cost (In ₹. crores)	21,700	10,000	7,000	7,000	**45,700**
Civil Engineers	260	700	250	440	**1,650**

The availability of civil engineers is quite inadequate to meet the rising demands of the aviation sector. In view of the increasing demands from all other infrastructure sectors, each one of which is growing rapidly, it is likely that the situation will get worse.

Even assuming that 2% of the estimated additional manpower of 120,000 (approx.) required over the next 10 years would be civil engineers, a lower bound, given the plans for the aviation sector include enhanced city-side facilities, the number comes out to 2440, an addition of nearly 1,800 to a base of 640.

Therefore for the next 5 years, the number of civil engineers to be added to the initial workforce of 640 would be about 550.

[16] Airport development programme, presented to the Committee on Infrastructure (CoI)

Annex 5/1

Airport Sector

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table : 5/1-1

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Inv. Plan (₹. Crores)	7,100	7,800	8,800	10,500	12,200	13,600
% increase		9.86	12.82	19.32	16.19	11.48
Manpower	640	696	777	918	1056	1166
Manpower Increase (Y-on-Y)		56	81	141	138	110
% increase		8.75	11.64	18.15	15.03	10.42

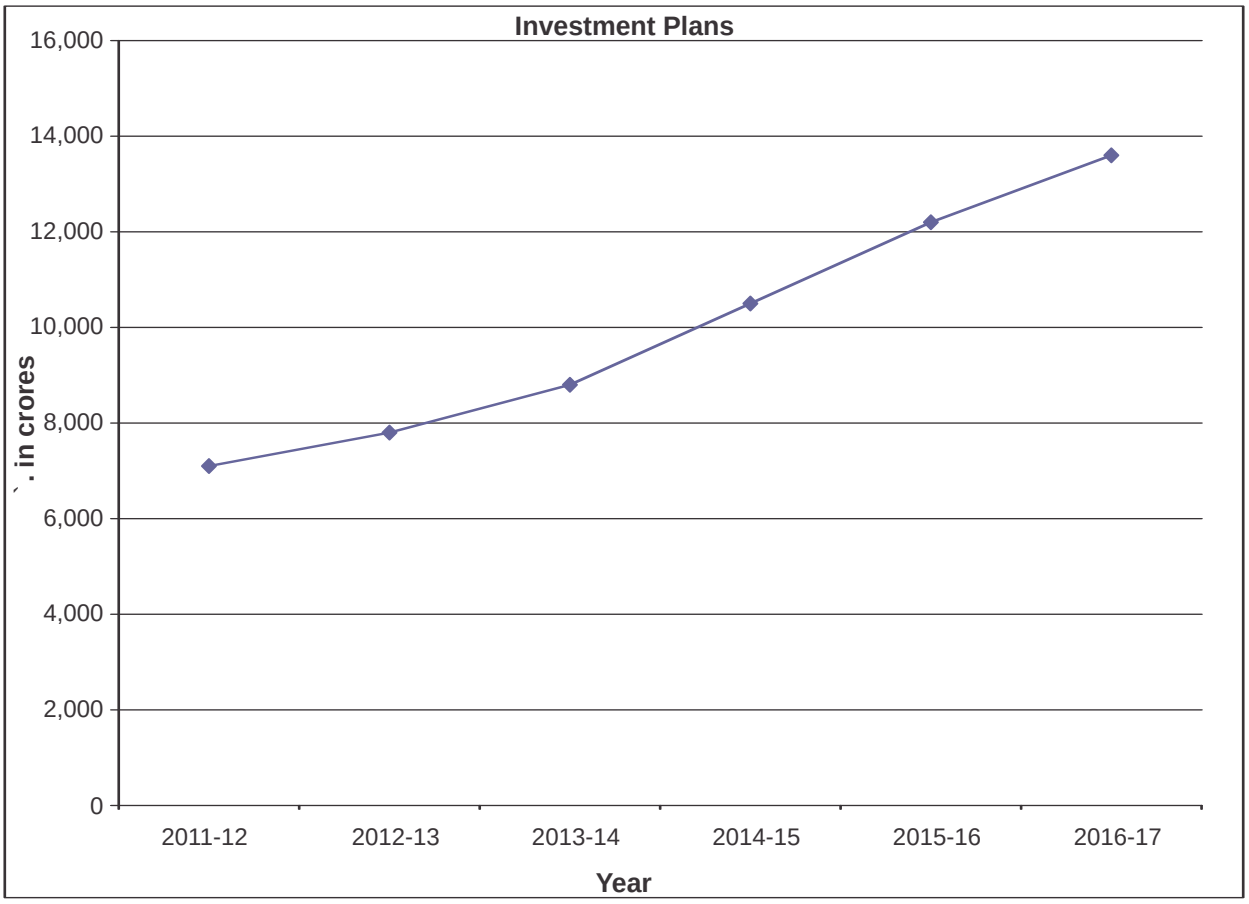


Fig. 5/1-1

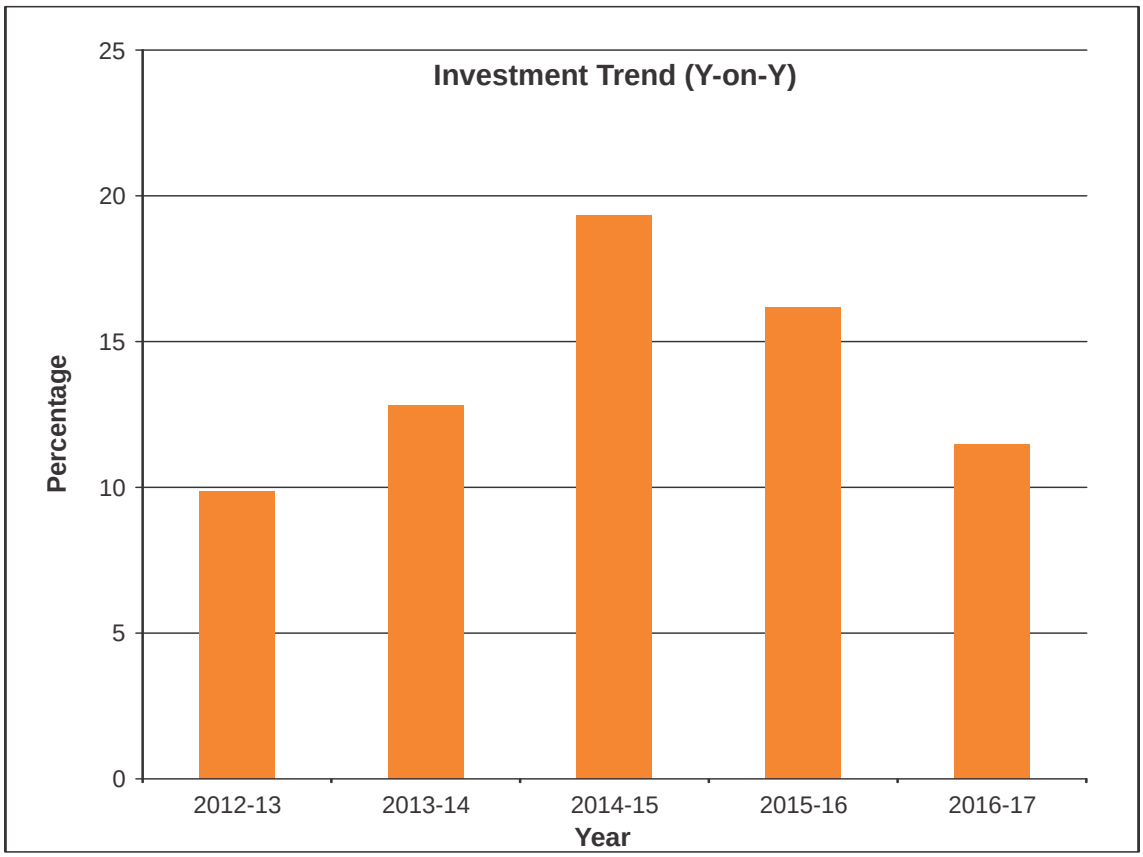


Fig. 5/1-2

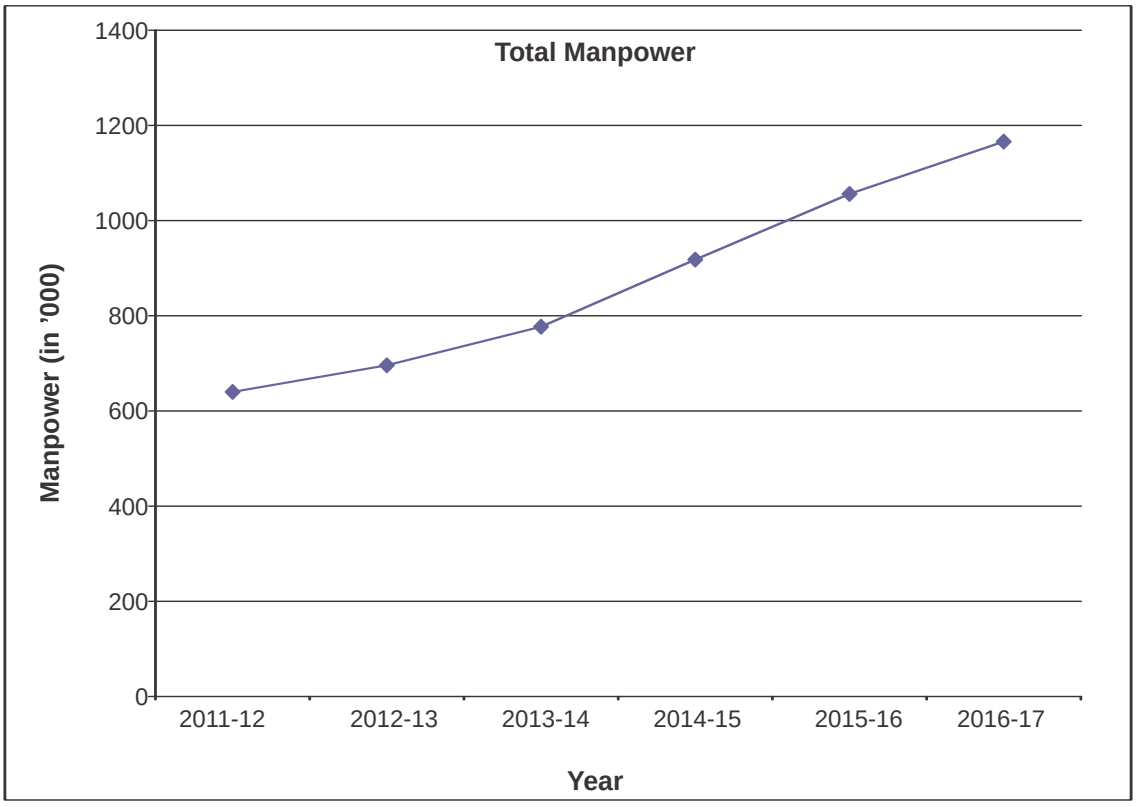


Fig. 5/1-3

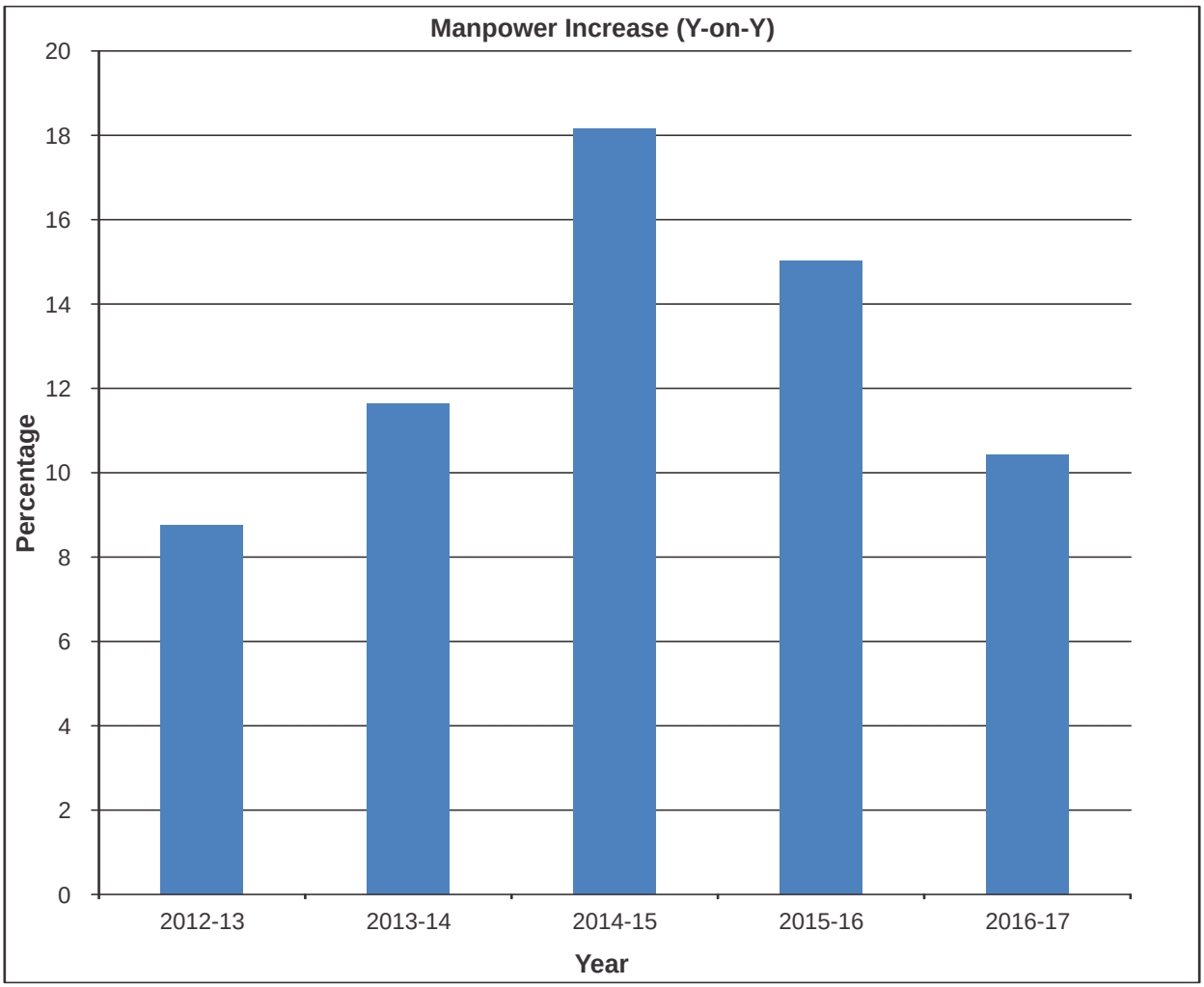

Manpower Increase (Y-on-Y)
Percentage
20
18
16
14
12
10
8
6
4
2
0
2012-13
2013-14
2014-15
2015-16
2016-17
Year

Fig. 5/1-4

CHAPTER 6

PORTS & INLAND WATERWAYS, SHIPBREAKING

6.1 Background

India has had a colorful maritime history befitting its 7,600 kilometers long coastline constituting one of the biggest peninsulas in the world. Maritime transport moves about 95% of India's trade by volume and 70% by value. This is likely to go up as the secondary sector of economy, manufacturing diversifies and improves.

There are 14 major ports, including 1 major corporate port and 187 notified minor and intermediate ports in the nine coastal states - namely West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat. Port Blair was the latest addition in June 2010 to major ports.

Given the focus on growth through exports – India is becoming a major manufacturing destination for goods for consumption across the world, witness the automotive sector – it is essential to strengthen port infrastructure. Initiatives are required in the areas of deepening of channels / berths etc. / new construction and reconstruction (retrofitting) of berths / jetties etc. / associated hinterland connectivity and / enhancing operational efficiency (reducing the turnaround time). Civil Engineering components in these activities would obviously play a significant role.

Several notified minor ports, with little or inadequate cargo handling facilities have been identified by the respective state governments and would be developed, in a phased manner, a good number of them in the Public-Private-Partnership mode.

Cargo handling is projected to grow at an annual rate of 7.7% until 2013-14. 70% (approx.) of India's container traffic is handled by Mumbai Port Trust and the Jawaharlal Nehru Port Trust (JNPT) in Navi Mumbai. The western arm of the Dedicated Freight Corridor is designed for freight aggregation at and disaggregation from JNPT. The proposed Delhi-Mumbai Infrastructure Corridor would also be integrated with the freight corridor and the port facilities in Maharashtra and Gujarat. The Petrochemical and Petroleum Investment Region (PCPIR) to be set up at Haldia on the Ganga is another facility with freight focus and so is the PCPIR in Baruch district of Gujarat. Multiplying the developmental impacts of these industrial investments would need the port sector to grow fast, with the active involvement of civil engineers.

The ship breaking industry has grown and expanded, in the past three to four decades, all over the world. It supplies substantial quantity of re-rollable and scrap steel for the iron and steel industry. The practice is inherently sustainable, given that more than 95 per cent of a ship can be recycled: steel is re-rolled for use in construction. This is a process that involves much engineering expertise including, Civil Engineering inputs.

While controversies do arise, as it did recently when asbestos was found to be involved, in general, it is an essential part of steel supply industry. This point is underscored by recent developments that do not send the salvaged material for melting and further processing; instead these are used as structural steel in almost "as is" condition. In the process, the utility of the material may suffer, but the cost of reprocessing is avoided and also, environmental benefits accrue.

Ship-breaking creates direct and indirect employment. Particularly in cases of re-using without reprocessing, Civil Engineering input will be of very high order.

6.2 Dimensions and Growth of Port Infrastructure and Activities

The focus of investments in the major Ports during the X FYP has been on additional capacity creation, as well as modernization / provision of quality service at competitive rates. The aggregate capacity in the 12 Major ports reached a level of 508.60 MTPA by end of the X FYP period as against 343.95 MTPA at the end of IX FYP period, an addition of 164.65 MTPA. The Major Ports have continued to maintain a favorable capacity-traffic equation during the entire X FYP period. Major capacity addition projects completed during the X FYP period include the development of the third container terminal at Jawaharlal Nehru Port, construction of an oil berth at Paradip port, port facilities for Mangalore Refineries and Petrochemicals Limited at New Mangalore Port, construction of berths 5A and 6A at Mormugao Port and oil jetty and related facilities by ESSAR at Vadinar in Kandla Port.

In 2009, cargo traffic at the Major ports reached 530.35 million tones and 212.14 million tones, at the minor ports. Container traffic was 93.09 million tonnes.

The Major ports handled 463.24 MT of cargo during April 2009 - January 2010, was 3.7% lower than the targets for the period. But it recorded a growth of 6.0% over the achievement of 437.14 MT for the corresponding period of the previous year. The growth rate was higher than the rate of 3.0% achieved during April 2008 - January 2009. All ports, except Haldia, New Mangalore, and Ennore recorded positive growth.

Total coastal shipment of coal (thermal & coking) at all Major ports during this period at 60.57 MT, 12.8% lower than the target for the period; but it was 3.6% higher than the shipment of 58.46 MT during the corresponding period of the previous year.

Government of India has taken a number of initiatives during the recent past for the development of port sector. These include, inter alia, the Container Trans-shipment Terminal at Kochi, the first port based Special Economic Zone (SEZ) at Kochi, development of the fourth container terminal at JNPT, envisaging an investment of ₹. 55,803.73 crores under National Martitime Development Programme (NMDP). The break-up of these investments under NMDP is given in Table 6.1.

Table 6.1 : Proposed Investments under NMDP[17]

(in ₹. crores)

Project Head	No. of Projects	Budgetary Support	Internal Resources	Private Investment	Others	Total
Deepening of channels/ berths, etc.	25	2,731.00	3,340.00	185.00	48.00	6,304.00
Construction/ reconstruction of berths/jetties, etc.	76	563.00	3,867.33	28,083.24	50.00	32,563.57
Procurement of Equipments, etc.	52	0.00	1,427.87	1,075.00	130.00	2,632.87
Rail and Road connectivity works	45	90.00	2,232.24	0.00	3,634.25	5,956.49
Others	78	225.00	2,904.10	5,162.10	55.60	8,346.80
Total	**276**	**3,609.00**	**13,771.54**	**34,505.34**	**3,917.85**	**55,803.73**

[17] Working Group Report on Port Sector, Ministry of Shipping

NMDP also proposes to establish two shipyards of global standards, one on the east coast and the other on the west coast.

6.3 XI FYP

The main thrust in the ports sector in XI FYP is on capacity augmentation mainly through private sector participation, improvement in productivity, reduction in provision of dwell time, enhancing dredging capabilities / operations besides rail-road connectivity to hinterland. The XI FYP also envisages corporatization of ports and coordinated development of Minor ports.

Indian ports are expected to handle 800 million tones (approx.) of cargo by 2012, the end year of XI FYP. An investment of ₹. 61,013 crores proposed in the XI FYP is meant for construction and reconstruction of berths, provision of additional equipment and crafts, deepening of channels and other development projects for Major ports.

The XI FYP also provides ₹. 26,982 crores for development of Minor Ports including green field projects. An emerging thrust area in this sector is the development of international transshipment hubs at Cochin, Vizhinjam, and Positra.

Table 6.2 : Projected Investment in Ports during the XI FYP[18]

(in ₹. crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Major Ports	8,847	10,535	12,198	13,682	15,761	61,013
Non-Major Ports	3,562	4,288	5,186	6,298	7,649	26,982
All Ports	12,409	14,822	17,374	19,980	23,410	87,995
Public	5,496	6,356	6,967	7,146	7,550	33,516
Private	6,913	8,466	10,407	12,833	15,860	54,479

6.4 Projections for The XII FYP

Assuming that the total outlay for the XII FYP is likely to be double of that for the XI FYP, an amount of ₹.180,000 crores would be available for the maritime sector, of which the port section would get a major portion. This amount does not include the possible carry over from XI FYP which had a shortfall of more than ₹. 46,0000 crores. Even so, this is a huge window of opportunity for civil engineers which can be realized only if the availability of civil engineers matches the demand.

6.5 Ship Breaking

Ship breaking activities are concentrated at, among others; at Alang, Sosiya yards, and Sachana, (all in Gujarat), Mumbai and Kolkata. Some relevant data during the last three years and the year 2009-10 (upto December 2009) are at Table 6.3.

[18] "Projections of investment in Infrastructure during the 11th FYP", Planning Commission, GOI, 14th August 2008

Table 6.3 : Ship Breaking during 2006-2010[19]

Year	No.of ships beached	Light Displacement Tonnage(in MT)
2006-07	142	0.76
2007-08	140	0.60
2008-09	267	2.00
2009-10 (up to Dec 2009)	293	2.30

Steel generated from ship recycling contributes to around 1% to 2% of the domestic steel demand. This is not an insignificant contribution to the economy considering the very low energy requirements, particularly when the salvaged material is to used almost in "as is" condition.

Alang / Sosiya is the world's largest scrapping yard for ocean-going vessels. It has a ship breaking capacity of 350 ships a year, about four million tons per annum, and produces about 2.5 million tons of re-rollable steel. According to figures provided by give Gujarat Maritime Board (GMB), 5,052 vessels were dismantled in Alang since 1982, (approximately one every two days) when the first yards were set up. In the last four years alone, more than 784 end-of-life ships arrived in Alang – 248 in 2009. Some 60,000 workers are employed in the yards when the industry works at full force. In addition, more than 5,00,000 workers are employed in associated downstream industries, such as re-rolling mills, foundries, scrap-handling yards, local goods stores and other small businesses.

The scale of operations in Mumbai is much smaller than those in Alang / Sosiya. When working at full capacity, the yards provide employment to about 6,000 workers. The total number of workers directly or indirectly employed in the ship-breaking industry is about 20,000, which include the downstream industries generated by the ship-breaking yards.

To sum up, the ship breaking industry employs more than one lakh workers.

6.6 Inland Waterways

India has an extensive network of inland waterways operating through rivers, canals, backwaters and creeks. The total navigable length is 14,500 km, out of which about 5,200 km of river and 4,000 km of canals can be used by mechanised crafts. Freight transportation by waterways is very low in India compared to other large countries and geographic areas like the United States, China and the European Union. The total cargo moved (in tonne kilometers) by inland waterways was just 0.1% of the total inland traffic in India, compared to 21% for United States. Cargo transportation in an organized manner is confined to a few waterways in Goa, West Bengal, Assam and Kerala.

Even so, the trained manpower engaged in this sector is grossly inadequate and amounts to less than 1,000.

6.7 Manpower Projections

Indian port sector has been undergoing major structural changes during the last decade, replacing the age-old labour intensive systems with modern mechanical cargo handling operations. As on 2008, the total workforce in the port sector was 11,02,000 and an incremental workforce of 14,49,000 is expected until 2022 to meet the targets set for the next 12 years in infrastructure development.

[19] Statistics as furnished by the Iron Steel Scrap & Ship Breakers Association of India

At the national level, at present there are two ISO certified institutes viz, Indian Institute of Port Management (IIPM), Kolkata and the National Maritime Academy (NMA) formerly known as National Institute of Port Management, Chennai. These two institutes play an important role in imparting training in the maritime sector in general and ports in particular. These develop and conduct various training programmes throughout the year on all functional areas of port operation and management and also on areas of current interest.

IIPM also conducts courses on Inland Waterways Transport (IWT) at National Inland Navigation Institute (NINI) at Patna. Some details of their performance during the years 2003-2006 in terms of number of courses conducted / participants trained are given in Table 6.4.

Table 6.4 : Development of IWT Manpower at NINI Patna

Year	Number of courses conducted	Number of participants
2003-04	443	5391
2004-05	623	7479
2005-06	582	5758

The participants in the courses conducted in these two institutes are mainly engineers and supervisory staff.

The investment envisaged the XII FYP is ₹.1,80,000 crores and for execution of the civil work component only, the approximate number of civil engineers required is estimated at 1,06,000. And making provision for the carry-over from the XI FYP, we require about 21,000 civil engineers per year.

Annex 6/1

Ports & Inland Waterways, Shipbreaking

This Annex presents the data regarding the Civil Engineering manpower requirements in the last section of Chapter 6 – Ports and Inland Waterways.

Table 6/1-1 : Investment in Port Sector(XI FYP)

(In ₹. crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Major Ports	8,847	10,535	12,198	13,682	15,761	61,013
Non-Major Ports	3,562	4,288	5,186	6,298	7,649	26,982
Total	12,409	14,822	17,374	19,980	23,410	87,995
Revised Total	4,942	7,148	8,323	9,454	10,779	40,647

A typical port project worth ₹. 280 crores for 1 year requires approximately 45 civil engineers to execute it, involving 3 at the design stage, 14 during construction supervision stage from the consultants side, 24 from the Contractor's side and 4 from Independent Consultants. This may be rounded off to 50 civil engineers for the execution of a project worth ₹. 300 crores. It must be understood that the above estimates are derived from typical projects and are to be allowed certain margin of errors.

Hence taking into account the carry-over of about ₹. 58,000 crores from the XI FYP and the XII FYP projection of ₹. 1, 80,000 crores on various Ports and IWT projects for a span of 5 years would require 1,06,000 civil engineers, translating into about 21,000 per year with the peak annual requirement at about 31,000.

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table 6/2-1

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Inv. Plan (₹. Crores)	10,800	13,200	21,000	34,800	49,500	61,500
% increase		21.2	58.1	64.7	41.2	23.2
Manpower ('000)	24	29	46	75	106	130
Manpower Increase (Y-on-Y)		5	17	29	31	24
% increase		20.83	58.62	63.04	41.33	22.64

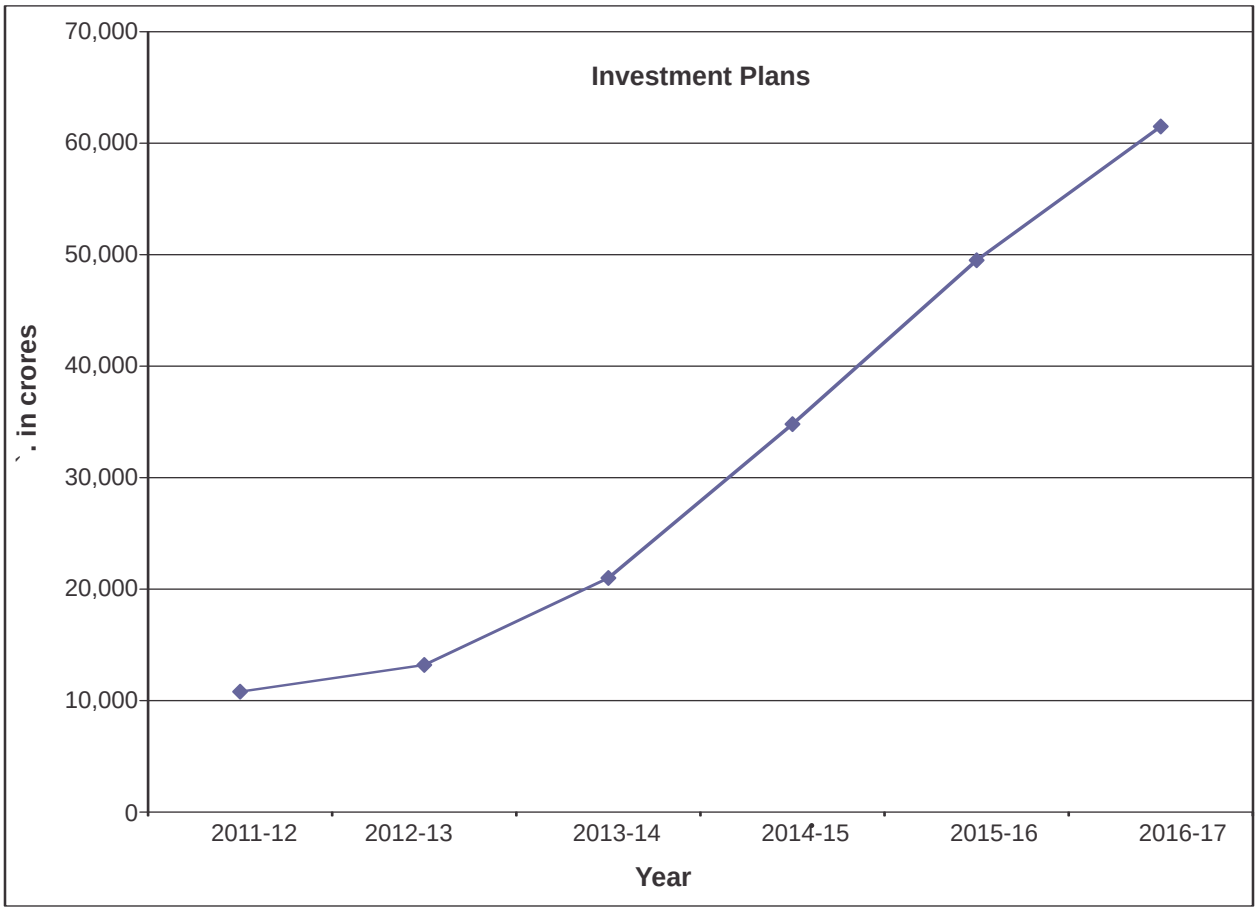


Fig 6/2-1

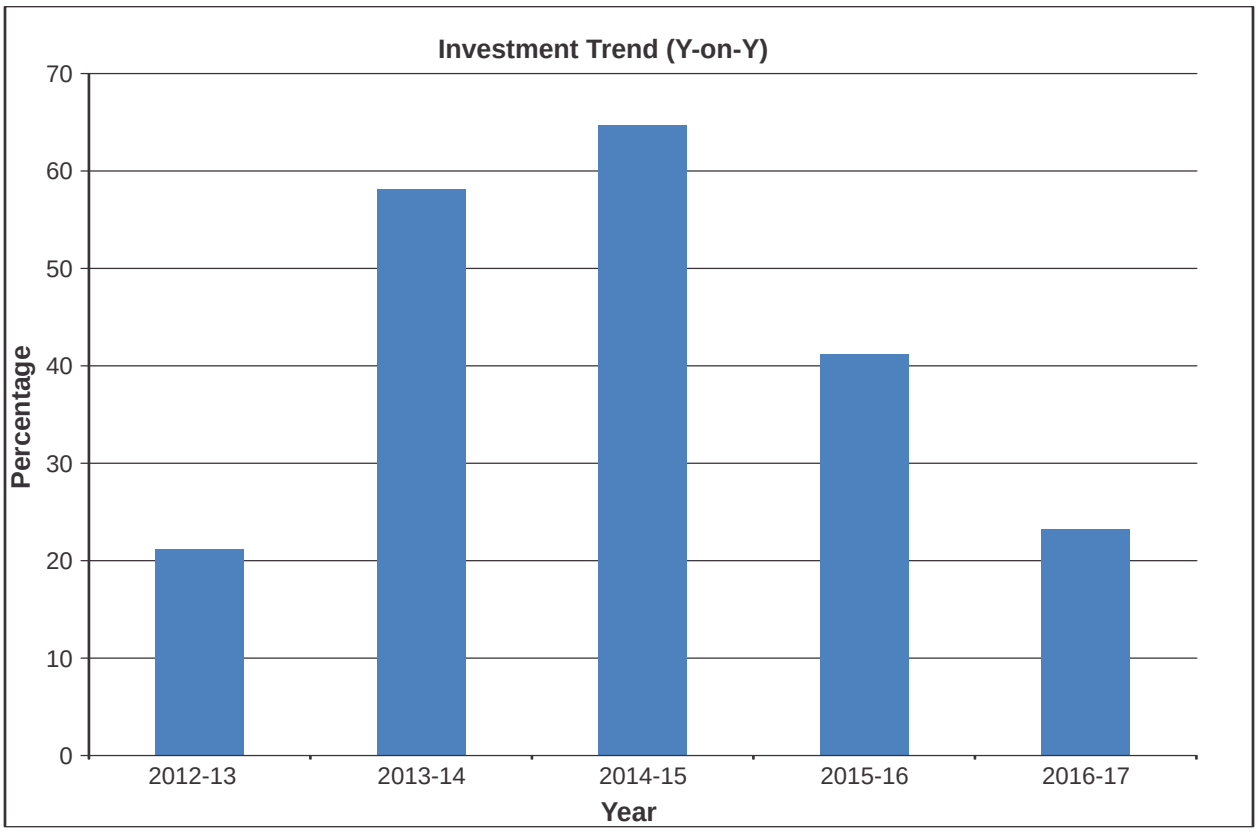


Fig. 6/2-2

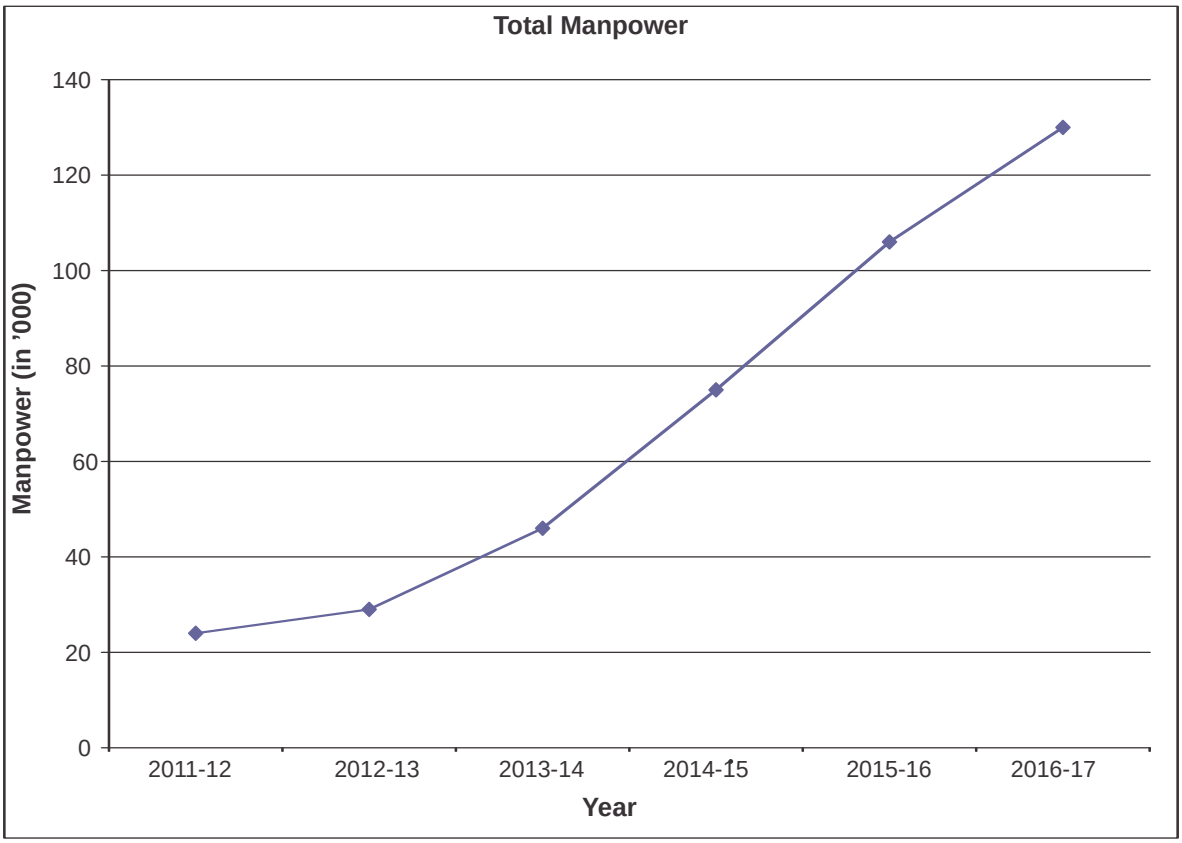


Fig. 6/2-3

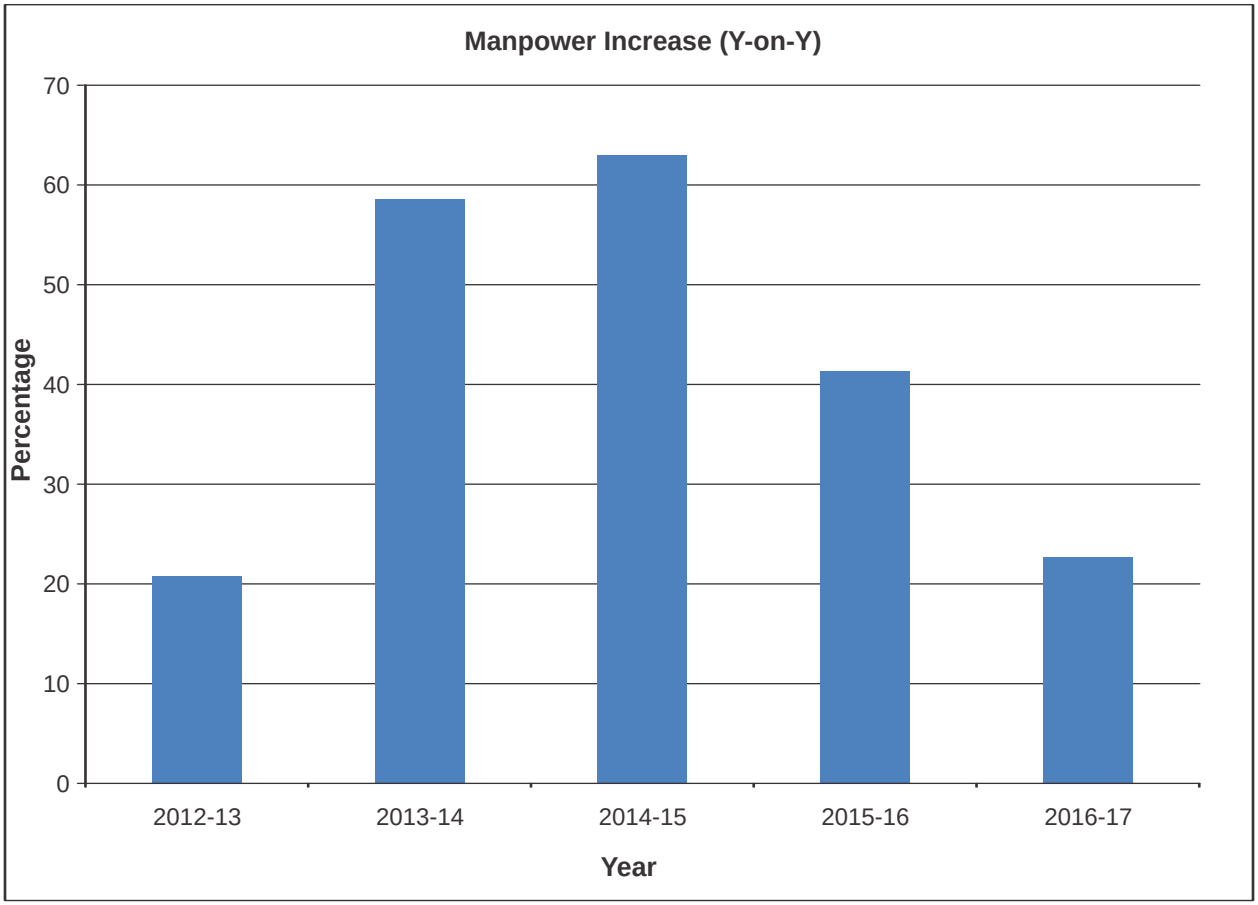

Manpower Increase (Y-on-Y)
70
60
50
40
30
20
10
0
Percentage
2012-13
2013-14
2014-15
2015-16
2016-17
Year

Fig. 6/2-4

CHAPTER 7

IRRIGATION
(Incl. Watershed Development)

7.1 Background

India is still a largely agrarian country as 85% of the economy's water requirement is from agriculture (irrigation) against a global average of 69%. Irrigation accounts for by far the largest part of total investment in the agricultural sector. Hence its importance as a crucial infrastructure sector with particular significance for our food security.

Irrigation is expected to consume 910 BCM (billion cubic meter) of water by the year 2025, an increase of 32% over 2010. In aggregation, India is an acknowledged water-stressed country and there is a premium in enhancing the efficiency of use water allocated for agriculture and other uses. Further, efficiency in the utilization of the resource needs to be improved under the various scenarios of climate change, including mitigation and adaptation procedures.

The XI FYP had acknowledged the significance of this sector by allocating about 12% of the Plan outlay to irrigation.

7.2 Performance of the Sector during X FYP

Investment in the Irrigation sector (incl. Watershed Development) during the X FYP was ₹. 1,11,503 crores resulting in an addition of 8.8 mha potential. With this, 42 mha of potential have been created under major and medium irrigation schemes out of the ultimate potential of 58.5 mha for major irrigation, as well as 60.4 mha and 81.4 mha for medium and minor irrigation respectively. The unutilized potential (at the beginning of the XI FYP), stood at nearly 41% each in the major and medium sector, and at 35% for minor projects.

Table 7.1 : Irrigation Potential – Ultimate, Created, and Utilized[20]

	Ultimate potential	Potential created	Potential utilized
MMI	58.47 mha	42.35 mha	34.42 mha
MI	81.43 mha	60.42 mha	52.81 mha
Total	139.9 mha	102.77 mha	87.23 mha

The position regarding completion of projects in the major and medium irrigation sector is given at Table 7.2.

[20] A report on the 11th FYP, Planning Commission, GOI

Table 7.2 : Projects in the Major, Medium & ERM Irrigation Sectors[21]

	Major	Medium	ERM*
Projects spilled into X FYP	171	233	86
New projects taken up	49	84	46
Projects to be completed by the end of X FYP	48	91	39
Spill-over projects into XI FYP	166	222	89

**Extension, Renovation, Modernization*

Although the expenditure targets in the X FYP were exceeded, the addition to potential created was only 50% of the target and there is hardly any increase in the irrigated area on the ground.

Command Area Development (CAD) Schemes: About 19 mha was covered under this programme for micro-level distribution system including field channels, field drains, etc., till the end of the X FYP. Under CAD Programme, 311 projects were included (with total Culturable Command Area (CCA) of 28.58 mha)

Table 7.3 : Physical progress under CADWM Programme[22]

Item	Total progress during the X FYP
Field channels	2.044 mha
Field drains	0.584 mha
Warabandi	1.053 mha
Land leveling	0.050 mha
Total	3.73 mha

Flood Management: A total of 18.22 mha have been protected against flood by the end of the X FYP. On an average, an area of 7.55 mha is affected by floods every year in our country and the average annual flood damage is ₹. 1,805 crore.

7.3 Performance of the Sector during XI FYP

The main objectives identified in the XI FYP are:

1. Creating around 16 mha of irrigation potential during the Plan period with the target of bringing at least 6.4 mha of new area under irrigation through:

- Timely completion of major and medium and minor irrigation projects
- Extension, renovation and modernization of MMI projects
- Minor irrigation projects (both through development of surface water as well as ground water resources)

[21] Report of the working group on Water Resources for the XIIth FYP (2007-2012), Ministry of Water Resources,GOI, December 2006

[22] Report of the working group on Water Resources for the XIIth FYP (2007-2012), Ministry of Water Resources,GOI, December 2006

- Restoration of existing water bodies.

2. Reducing gap between Potential created and Potential utilized

- Through improvement of the efficiency of the irrigation system
- Introduction of the system of Micro Irrigation with fertigation, crop diversification and multiple use of water, etc

3. Mitigation of flood damages.

The thrust areas identified to achieve the objectives are: Completion of ongoing irrigation projects; Extension, Renovation & Modernisation (ERM) of old schemes; Improvement in the efficiency of irrigation system; Command Area Development and Water Management; Sustainable Ground Water Development and Management; Dam Safety Measures; Water Resource Information System; On line monitoring system; Flood management. It is evident that involvement of civil engineers, in all programmes including the Water Resources Information System, (nominally an IT system but with deep domain components) will be widespread and deep, in this as well as the succeeding plans. The discipline has to prepare itself, for such involvement, first by assessing the manpower requirements.

Table 7.4 : Projected investment, category-wise during the XI FYP[23]

(₹. in crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Major & Medium Irrigation	17,073	23,354	31,957	43,742	57,834	1,73,960
Minor Irrigation	3,938	4,983	6,309	7,992	10,133	33,355
Command Area Development	1,485	1,758	2,086	2,480	2,954	10,763
Flood Control	1,258	1,424	1,614	1,832	2,087	8,215
Watershed Development	3,743	1,398	5,223	6,220	7,426	27,009
Total	27,497	35,916	47,189	62,266	80,433	2,53,301

Taking into account substantial investments planned for Bharat Nirman Programme under the States' thrust on irrigation sector during the XI FYP, the projected investment by States and Centre are given in Table 7.6.

[23] Report of the working group on Water Resources for the XIIth FYP (2007-2012), Ministry of Water Resources, GOI, December 2006

Table 7.5 : Physical Targets for the XI FYP[24]

No. of projects	Major	Medium	ERM
• Completion of Projects			
○ X FYP projects spilling into XI FYP	166	222	89
○ New projects of XI FYP	78	145	86
Total	**244**	**367**	**175**
Projects likely to be completed in the XI FYP	72	133	132
• Creation of potential (in mha): 16 MHA (total)			
Under MMI Sector: 9 mha			
Under MI Sector:			
○ Surface water – 1.5 mha			
○ Ground water – 4.5 mha			
○ Restoration of water bodies – 1.0 mha			
• Physical targets for CADWM (in mha)			
○ Development of Culturable Command Area (CCA)- 3.5 mha			
○ Correction of conveyance deficiency – 6.25 mha			
○ Reclamation of water logged, saline and alkaline lands – 0.5 mha			
• Physical target under Flood control works (in mha) ○ Area to be protected against flood: 2.18 mha			

Table 7.6 : Projected investment, Centre-State Split during the XI FYP[25]

(In ₹ crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Centre	3,367	4,006	4,782	5,726	6,879	24,759
States	24,130	31,911	42,407	56,540	73,554	2,28,543
Total	**27,497**	**35,916**	**47,189**	**62,266**	**80,433**	**2,53,301**

Guidelines for the Accelerated Irrigation Benefits Programme (AIBP) have already been changed to expand the scope of the programme and to increase the Central share for selected areas. Much greater emphasis is required on investments in physical rehabilitation and on modernisation of systems essential for improving the efficiency of water use.

As per the Mid-term Plan appraisal, it is estimated that by the end of XI FYP irrigation potential of 12 mha will be added instead of the 16 mha projected. However, in view of past trends, the level of achievement in the X FYP and the outlay proposal for the XI FYP, the Working Group of the Planning Commission has rationalized the target to 9 mha. Hence, the left over component amounting to 44% of the original target needs to be carried over to the XII FYP.

7.4 XII FYP and the Way Forward

The XII FYP will have an estimated investment of ₹. 5,40,000 crores in this sector, assuming an apportionment of about 12% of total Plan outlay as in the XI FYP.

Given the deficit from the XI FYP targets of about 44%, the XII FYP, to be successful, has to cover that deficit and complete what is envisaged for itself. It is truly ambitious, particularly considering that environmental and sociological issues, which generally take time to be resolved amicably, are likely to take centre stage in the context of climate change debate and the paradigm of inclusive development.

[24] Report of the working group on Water Resources for the XIIth FYP (2007-2012), Ministry of Water Resources, GOI, December 2006

[25] "Projections of investment in Infrastructure during the 11th FYP", Planning Commission, GOI, 14th August 2008

475 out of India's 4,525 dams are under construction. Dam safety is an inherent function in the planning, design, construction, maintenance and operation of dams. The dam safety practices at the Centre as well as in the states is a continuous process requiring regular improvement and upgrading of technical knowledge in line with state-of-art technologies and international practices and techniques. Only a beginning has been made for an active dam safety programme in the country. A lot more requires to be done in future to assess the structural and hydrological safety of about 4,050 dams (constructed already) in accordance with the current dam safety practices and standards. The state governments are ill equipped both in terms of expertise and analytical tools and would depend on the Centre for technical expertise. The task ahead is huge for which the engineering workforce as a whole and in particular the Civil Engineering workforce needs to be augmented quickly.

7.5 Employment Generation and Requirement of Civil Engineers

In 2008, the total manpower available in this sector was estimated at 46,13,000. Assuming 2% of the workforce are graduate civil engineers, their number may be taken as 90,000. Working over 5 years, they have been able to absorb an investment of ₹. 2,46,234 crores (revised estimate, Annex 7/1), leaving a deficit of ₹. 7,000 crores to be mopped up during the XII FYP.

Increase in irrigated area generates additional employment in a continuing stream. Water resources projects, particularly irrigation development and flood control works, generate significant employment opportunities during construction period as well as in the post-project execution phase. The overall employment potential likely to be generated in the irrigation sector is given at Table 7.7.

Table 7.7 : Overall Employment Potential (Million Man Years) until 2020[26]

	Direct Employment	Indirect Employment
MMI	2.1	10.1
MI	5	1.05
Flood Control	2.5	-
Total	9.6	11.15

The annual direct employment in this sector will be 9,60,000 man years. Direct employment generation includes highly skilled, semi-skilled and unskilled personnel during construction stage. High-end jobs include engineers, technicians, administrative personnel, service sector professionals, etc. Indirect employment opportunities would arise in i) Farm sector, ii) Live stock sector, iii) Rural non-farm sector.

Analyzing the number of irrigation projects that would spill over to the XII FYP, and the massive investment planned for the XII FYP itself, it is estimated that, by the end of the XII FYP period, there would be a requirement for about 1,000,000 man years at the level of graduate civil engineers. (refer Annex 7/1 for the annual projected requirements up to 2017). As mentioned earlier, the above estimate assumes about 2% of the man years would be provided by graduate civil engineers, (irrigation projects being labor and machine intensive), beyond IT enabled engineering analysis. At the peak period of enhancement, the addition may be as much as 42,000 in one year.

[26] Report of the working group on Water Resources for the XIIth FYP (2007-2012), Ministry of Water Resources, GOI, December 2006

Annex 7/1

Irrigation

Investments in the irrigation sector in the XI FYP has been at set at 12% for the XI FYP and the distribution is given at Table 7/1-1.

Table 7/1-1 : Investment in Irrigation Sector (XI FYP)

(in ₹. crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Major & Medium Irrigation	17,073	23,354	31,957	43,742	57,834	1,73,960
Minor Irrigation	3,938	4,983	6,309	7,992	10,133	33,355
Command Area Development	1,485	1,758	2,086	2,480	2,954	10,763
Flood Control	1,258	1,424	1,614	1,832	2,087	8,215
Watershed Development	3,743	1,398	5,223	6,220	7,426	27,009
Total	**27,497**	**35,916**	**47,189**	**62,266**	**80,433**	**2,53,301**
Revised total	**38,789**	**44,858**	**49,093**	**54,045**	**59,449**	**2,46,234**

The current absorption capacity is to the tune of ₹. 60,000 crores per year for the total manpower strength of 46,13,000 in the sector which at 2% translates into 90,000 graduate civil engineers. Data from Table 7/1-1 also indicate an upper limit of about 10% increase in the absorption capacity. However, at this rate of increase, the targets will certainly be missed, leaving large gaps.

Recognizing that about ₹. 60,000 crores is the Plan expenditure in the last year of the XI FYP and the outlay during the XII FYP would be ₹. 5,40,000 crores, the total expenditure amounts to ₹. 6,00,000 crores to be absorbed by 2017.

If we assume that by the end of 2020, we would require 2,88,000 Civil Engineers, 28,800 would be employed each year. Hence in the next 6 years, for a sum of ₹. 6,00,000 crores, 2,01,600 Civil Engineering man years are required. That is, the additional Civil Engineering graduate requirement is 1,39,000.

It is noticed with concern that the achievements of the core engineering professions, in particular, Civil Engineering, are not being acknowledged properly by the society. In this scenario, it would be extremely difficult to attract properly qualified personnel to meet the infrastructure requirements. This is a concern which extends to every one of the infrastructure sectors.

Annex 7/2

Irrigation

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table 7/2-1

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Inv. Plan (₹. Crores)	60,000	66,000	82,000	109,000	132,000	151,000
% increase		10	24	33	21	14
Manpower ('000)	98	107	132	174	209	237
Manpower Increase (Y-on-Y)		9	25	42	35	28
% increase		9.18	23.36	31.82	20.11	13.40

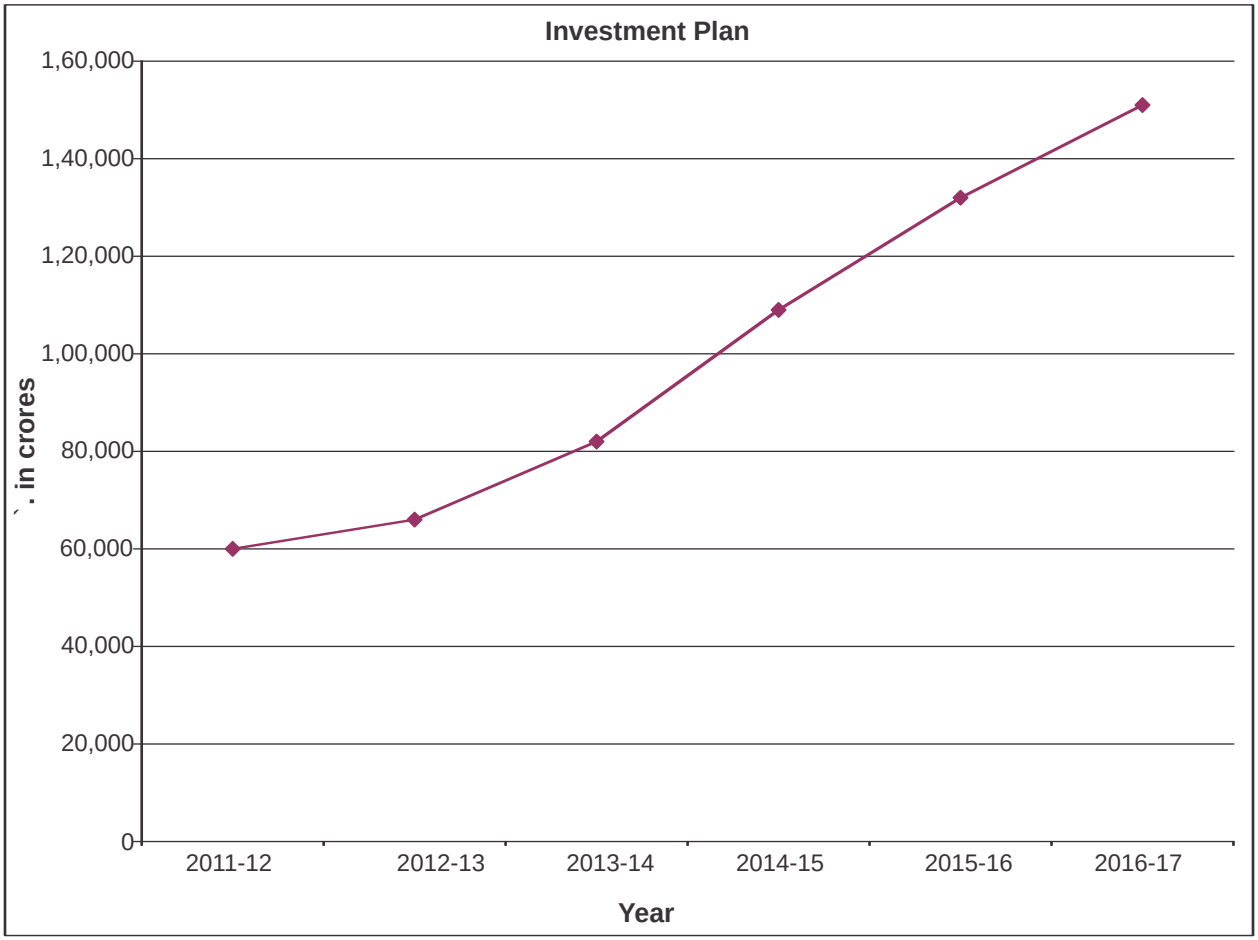
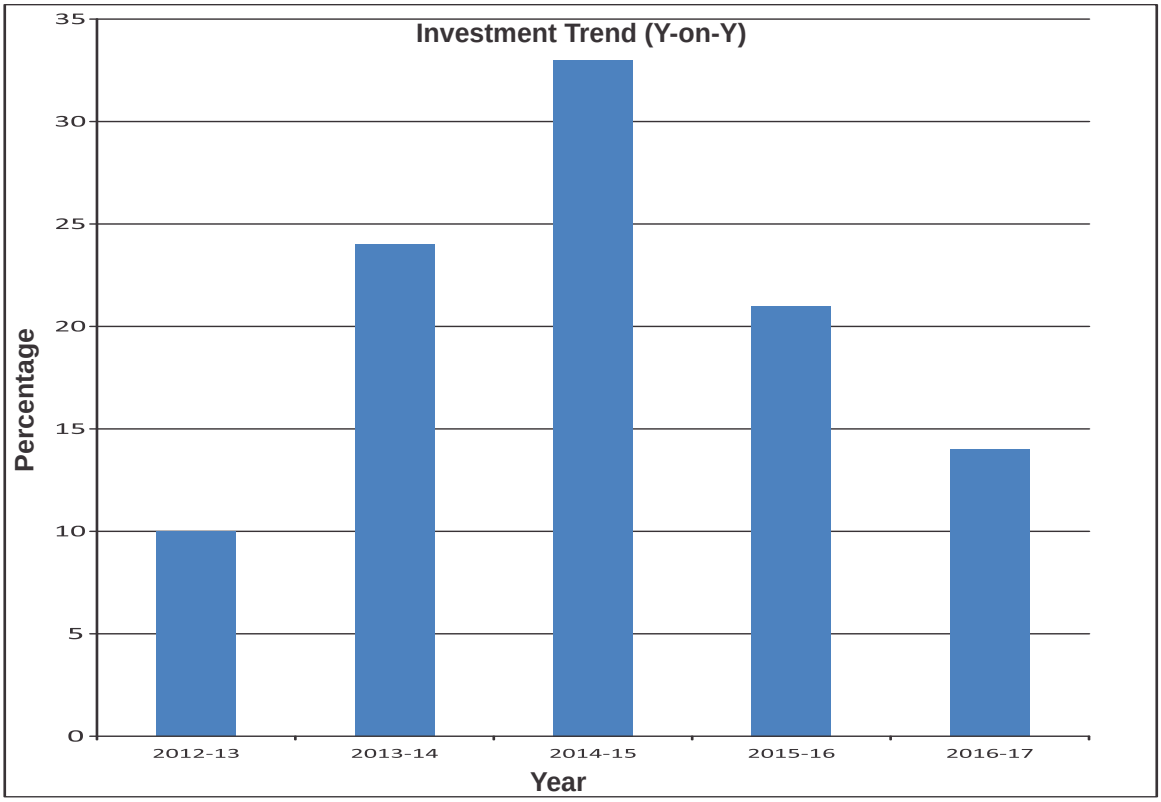


Fig. 7/2-1



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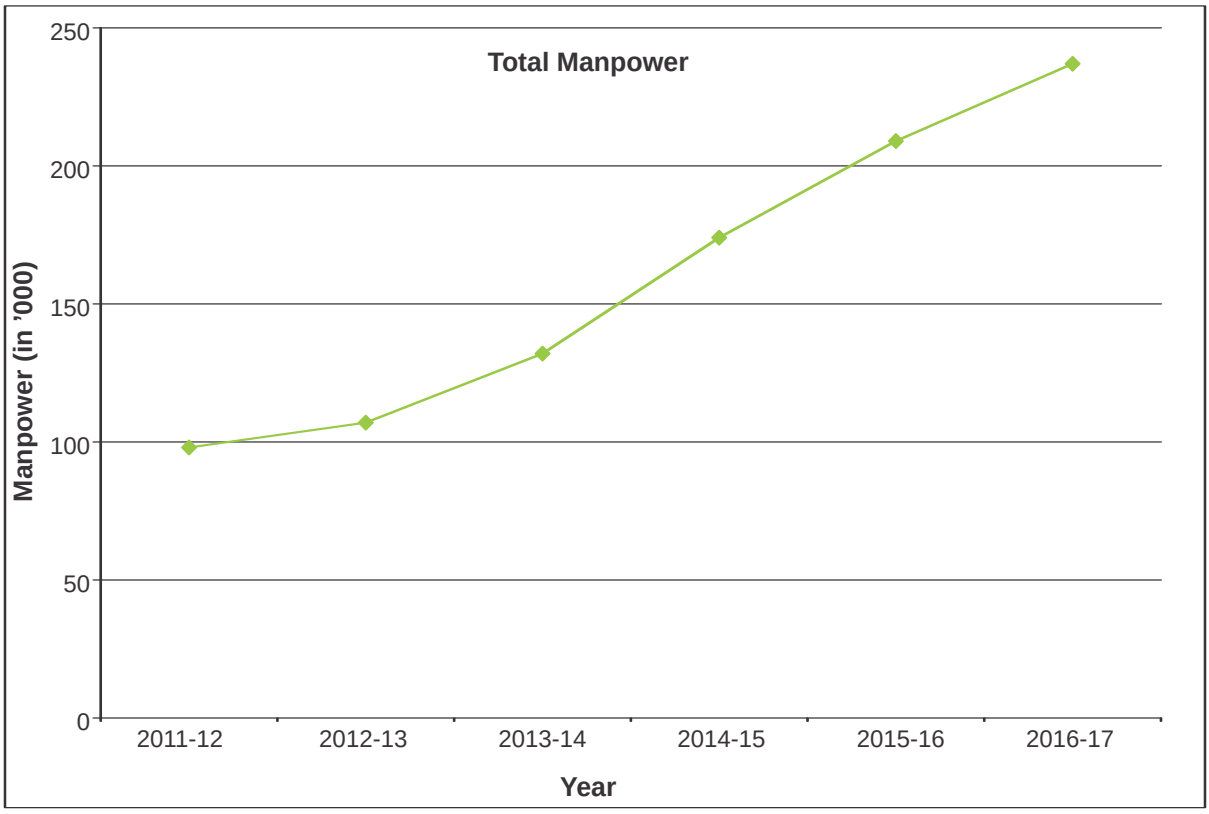


Fig. 7/2-3

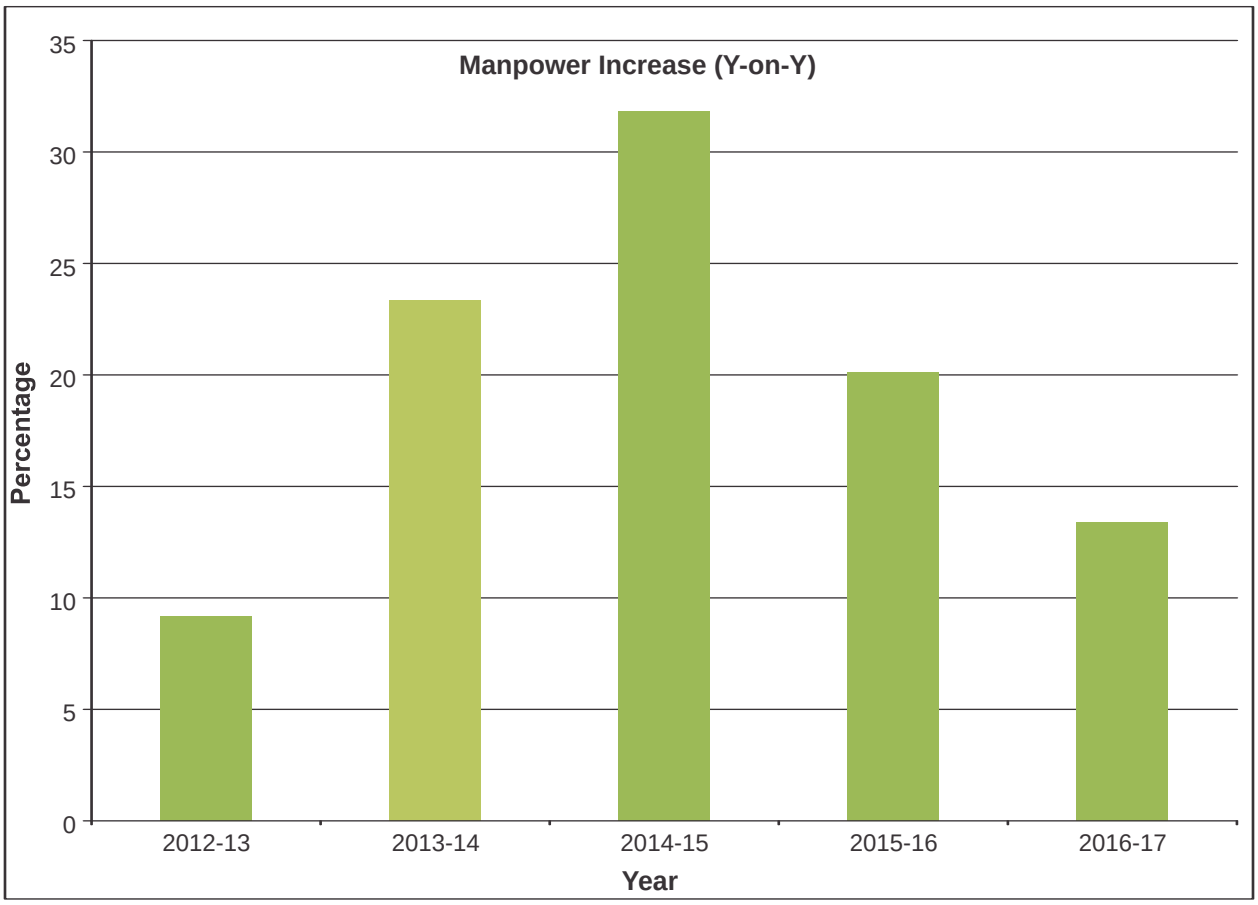

Manpower Increase (Y-on-Y)
Percentage
35
30
25
20
15
10
5
0
2012-13
2013-14
2014-15
2015-16
2016-17
Year

Fig. 7/2-4

CHAPTER 8

ENERGY AND POWER
(incl. Non-Conventional Energy)

8.1 Background

As irrigation underpins the agriculture sector, so do energy and power the manufacturing sector, (along with transportation), through logistics. Even agriculture is becoming increasingly dependent on power, given the reliance on ground water resources. Rapid urbanization has also increased the demand for power, particularly in augmenting the distribution infrastructure at the load centres. The services sector demands a built-up environment with a high level of amenities and reliable power supply of good quality. For all these reasons, a very heavy upsurge in power demand has to be provided for.

At the same time, the emphasis must be on making the sector efficient in resource use and reducing adverse environmental impacts. Environmental issues are likely to gain prominence in the coming years with increasing concerns about climate change. Hence, it is incumbent upon the engineering profession, particularly civil engineers, to plan ahead and assess the availability of appropriate manpower.

8.2 Performance in the Previous Three Five Year Plans - Analysis & Trends

The performance of this sector vis-à-vis Plan Projections has been rather unsatisfactory over the past three Plan periods. Capacity addition has consistently fallen short of targets in successive plans. In the last three Plans (VIII FYP to X FYP), the average capacity addition was around 50.5 per cent of the target capacity addition. Actual capacity addition of 16.4 GW during VIII FYP was 46 per cent less than the target, namely 30.5 GW. This trend continued in the IX FYP, with a deficit of more than 21 GW. Performance in the X FYP was similar, and only 51% of target capacity addition was achieved. The total capacity addition in these three Plans (VIII, IX and X) was 56,518 MW of which 44% was in the Central sector, 40% in the State sector and 16% from the private sector. The private sector contributed only 8.71% of the actual capacity addition in XIII FYP, 26.6% in IX FYP and 12.67% in the X FYP.

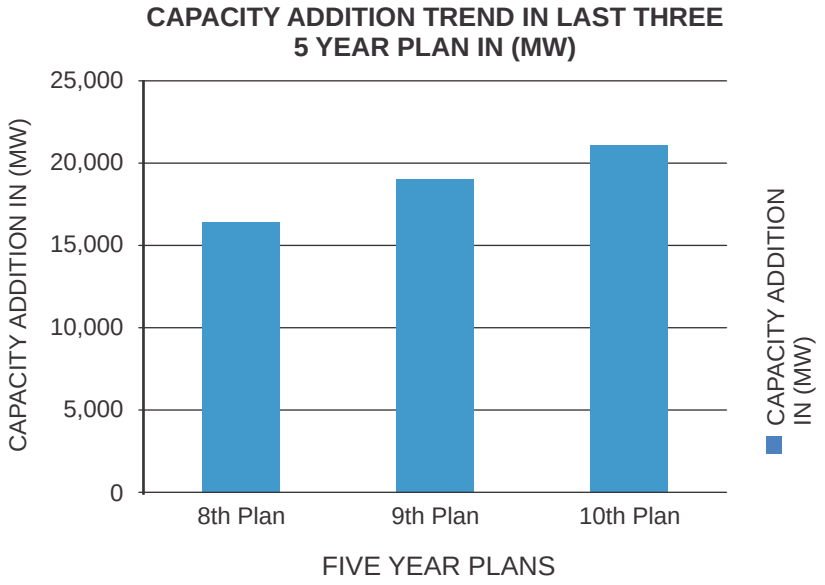


Fig. 8.1 : Trend of Capacity Addition – VIIIth, IXth and Xth FYPs

Table 8.1 : Power Generation Capacity Addition (Top-down estimates)[27]

(In MW)

Sector	VIII FYP	IX FYP	X FYP
Central	8,157	4,504	12,165
State	6,835	9,450	6,244
Private	1,430	5,061	2,671
Total	**16,422**	**19,015**	**21,080**

The persistent tendency to underperform vis-à-vis the targets is because of various structural deficits, one of which is the lack of human resources to effectively absorb the Plan outlay. In particular, the scarcity of engineering skills is a big deficiency. It might be held that shortfalls in mechanical and electrical engineering skills / inputs would be the important factors in this scenario. However, a pragmatic view would bring out that beyond the cost of capital and machinery, Civil Engineering contributes significantly in establishing power generation units as well as the infrastructure to evacuate / transmit / and distribute power. Hence, for avoiding persistent deficits, across generation, transmission and distribution, we need to look at one of the main sources of the problem – availability of civil engineers.

8.3 XI FYP – Power Sector Performance

The XI FYP originally envisaged a capacity addition of 78,700 MW. The sector-wise and sourcewise break-up is given in Table 8.2 below.

Table 8.2 : Original Targets for Capacity addition during XI FYP[28]

(In MW)

Source/Sector	Hydro	Thermal	Nuclear	Total
Central	8,654	24,840	3,380	36,874
State	3,482	23,301	-	26,783
Private	3,491	11,552	-	15,043
Total	**15,627**	**59,693**	**3,380**	**78,700**

The target implied that capacity creation in the XI FYP would be more than 3.5 times the capacity actually added in the X FYP. Ramping up capacity addition takes time and the capacity commissioned up to 31 December 2009 was only 19,092 MW. The revised target for total capacity addition is 62,374 MW which is lower than the original target. However, it is anticipated that additional capacity aggregating to 43,282 MW can be commissioned during the remaining period of XI FYP.

[27] Mid-term Appraisal Of the Eleventh Plan Report on the Energy Sector, Planning Commission, GOI, April 2010
[28] Mid-term Appraisal Of the Eleventh Plan Report on the Energy Sector, Planning Commission, GOI, April 2010

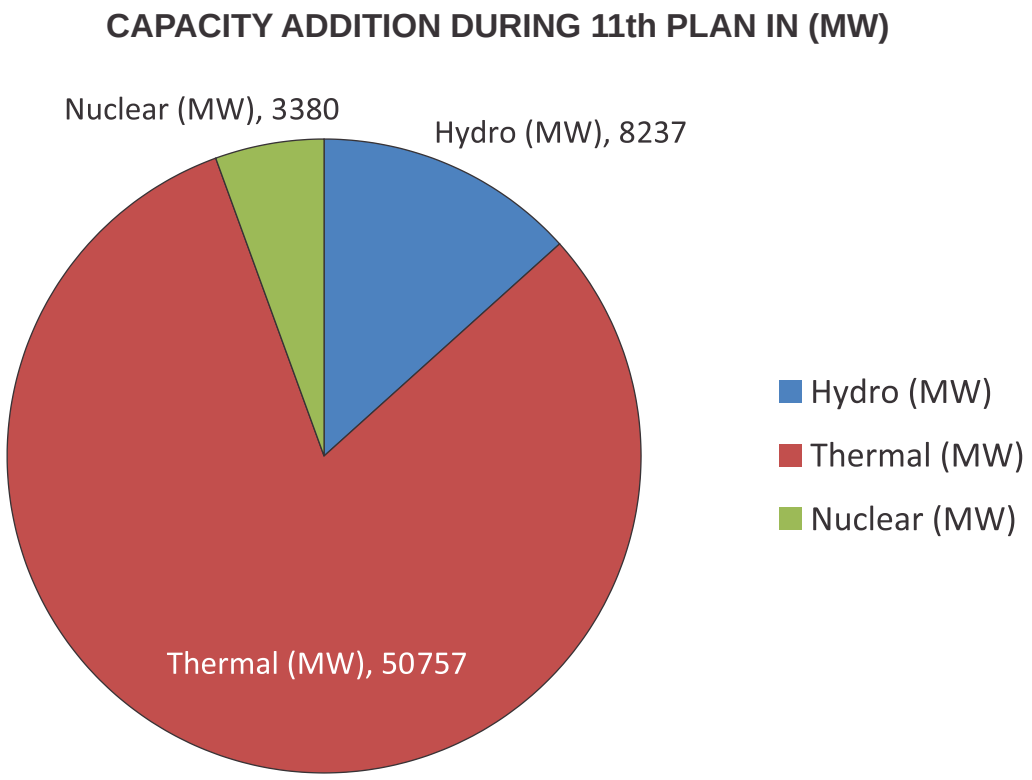


Fig. 8.2 : Revised Targets for Capacity addition during XI FYP

Table 8.3 is very revealing of the performance in this sector as per the targets.

Table 8.3 : Original Targets for Capacity addition during XI FYP[29]

(In MW)

	Hydro	Thermal	Nuclear	Total
Capacity as on 31st March 2007	34,654	86,015	3,900	1,24,569
XI FYP Target	15,627	59,693	3,380	78,700
Likely addition during XI FYP	8,237	50,757	3,380	62,374
Likely installed capacity on 31st March 2012	**42,891**	**1,36,772**	**7,280**	**1,86,943**

As per a study, meeting the demand will require a tripling of installed capacity from the current level of about 140 GW.

[29] Mid-term Appraisal of the Eleventh Plan Report on the Energy Sector, Planning Commission, GOI, April 2010

Table 8.4 : Manpower Estimates[30]

Category	Construction	Operation & Maintenance	To accelerate construction	Total
Engineers	20,000	40,000	6,500	**66,500**
Supervisors	33,000	75,000	12,000	**1,20,000**
Skilled workers	67,000	60,000	23,000	**1,50,000**
Semi-skilled	73,000	65,000	22,000	**1,60,000**
Unskilled	1,48,000	75,000	49,000	**2,72,000**
Non-technical	84,000	1,20,000	27,500	**2,31,000**
Total	**4,25,000**	**4,35,000**	**1,40,000**	**10,00,000**

8.4 Implications of Climate Change

It is somewhat surprising that the XI FYP is not very forthcoming on power generation from renewable energy sources other than hydroelectric. Even in the hydroelectric sector, we have been more concerned with large projects and have not paid enough attention to local generation and distribution for our remote rural hinterlands. Further, the country has significant potential for generation of power from Non-Conventional Energy Sources such as Wind, Small Hydro, Bio-Mass and Solar Energy.

The X FYP had achieved a capacity addition of about 6,750 MW and the total installed capacity as on 31.3.2007 was 10,256 MW. In terms of physical achievement, grid interactive electricity generation, a capacity addition of 5,526 MW (up to 31 January 2010) was achieved against the XI FYP target of 11,829 MW, which is 46.7 per cent of the target. This implies that the major proportion of the target i.e. 53.3 per cent is to be achieved in the remaining two years of the XI FYP.

Table 8.5 : Tentative Targets for Renewable Power[31]

(In MW)

Sources/Systems	Target for XI FYP	Achievement (as on 31st Jan,2010)	Anticipated achievement (at the end of XI FYP)
Wind power	10,500	3,857	9,000
Bio-power & Waste-to-power	2,100	1,046	1,779
Small Hydro (up to 25MW)	1,400	620	1,000
Solar Power	-	3	50
TOTAL	14,000	5,526	11,829

[30] Report on "Requirement and Availability of Highly Skilled Manpower for the Power Sector", Ministry of Power, GOI, October 2007

[31] Mid-term Appraisal Of the Eleventh Plan Report on the Energy Sector, Planning Commission, GOI, April 2010

8.5 New Initiatives / Projects & Government Programs

The total installed power generation capacity in India reached 1,50,324 MW (on 30.06.2009). Additional (revised) Power Generation capacity to the extent of 62 GW is planned during the XI FYP with emphasis on:

• An efficient interstate and intra-state transmission system

• Rehabilitation of thermal stations and hydropower stations

• Development of ultra mega power stations (4,000 MW) through the PPP route. This will involve an investment of the order of ₹. 6,66,525 crores

• Almost 50% of the investment will go towards setting up additional thermal power generation capacity of about 46,000 MW

• Another ₹. 28,000 crores will be required for proposed electrification of 1.15 lakh un-electrified villages and establishing electricity connections to 2.34 crore BPL households by 2012 under the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

• The total programme size of APDRP (Accelerated Power Development Reform Programme) is ₹. 51,577 crores over a period of five years, out of which, ₹. 40,000 crores are earmarked for improvements to the urban distribution network for reducing T&D losses.

8.6 Demand for Power

India ranks as the world's sixth largest energy consumer accounting for about 3.5% of the world's total annual energy consumption, for about 19% of the global population. Per capita energy consumption is very low in India at 631kwh. much lower near than China. Even the anticipated increase in generation at present from about 160 GW to 315-335 GW by 2021-2022 can be considered only as an intermediate target. Power generation required to maintain the economy at the 9% annual GDP growth rate as well as the target of inclusive growth (with increased requirements a premium on distribution networks), the aim should be 420 GW by 2020.

8.7 XII FYP Projection

The total Plan outlay for the XII FYP is set at ₹. 46,12,500 crores and assuming that the sectoral allocation for power would be 32% the outlay will be in the range of ₹.14,72,000 crores. This number has to be analyzed in the context of the downward revision of the XI FYP, the feasible absorption capacity at around 22 GW per year during 2009-10 and 2010-11.

8.8 Projection for Manpower to Meet the Target Set at the End of the XII FYP

Achieving the targets in this sector, as in all the others, requires trained manpower for design, engineering, manufacturing, erection and commissioning of systems. Besides, trained manpower would also be required for operation and maintenance.

It may be noted that, while the capital equipment like turbines, system controls, power evacuation systems etc. count for a significant portion of the cost, in setting up a power generation facility, Civil Engineering inputs, not merely in terms of material, but also in terms of manpower requirements play an important role. One of the reasons is the vast range of engineering activities that come under the rubric of Civil Engineering. Of course, the involvement of civil engineers would vary between various types of power generation setups. For example, in percentage terms, a nuclear power plant is likely to have less involvement of civil engineers as compared to a coal fired thermal power plant, which in turn may require

less than that for an hydroelectric power station. However, the need to focus on Civil Engineering capacity and capabilities for augmenting power generation cannot be denied.

The manpower estimates given at Table 8.4 may be taken as the starting point for the XII FYP projections. Taking note of the variations in Civil Engineering inputs in the three dominant segments of this sector, namely, generation, transmission and distribution, a consolidated ratio of 10% may be taken as the involvement of civil engineers down to the semi-skilled level with 10% of them as graduates. Based on the above assumptions, it has been worked out that about 131,000 civil engineers need to be added to the workforce by 2017 (end of XII FYP). The peak annual requirement may be assessed at 35,000.

Annex 8/1

Energy and Power

This Annex presents the details in support of the conclusions drawn in the last section of Chapter 8 – Energy and Power.

Assessment of manpower (total and undifferentiated) required is done in an empirical manner, disaggregated among the different segments. The broad outlines of the assessment methodology are given below.

Construction of new power plants:

• Thermal (consolidated across fuel types): 8 persons per MW

• Hydroelectric: 10 persons per MW

• Nuclear: 8 persons per MW

• Wind/solar etc.: India's experience in these sectors is not adequate (because of low volume so far) and a statistical assessment may not be valid, even if it is carried out.

Transmission lines:

• 1 person per circuit kilometer (the trend is towards double and multi-circuit lines to accommodate higher power evacuation capacities from the mega generation projects; hence, the estimate may be taken as 1.25 persons per kilometer).

Project execution time:

• Normal tenure of a hydro project: 72 months

• Normal tenure for a nuclear project: 72 months, but the time frame for getting statutory clearances is essentially open ended.

Thermal power plant: 36 months

• Transmission and distribution facilities come in varying sizes and has high corridor and local specificities, and hence laying down a time frame is difficult.

Operation and Maintenance:

• Hydro power plant: 1.9 persons per MW

• Thermal (consolidated across fuel types): 1.1 persons per MW

• Transmission: 27.5 persons per 100 circuit kilometers.

Distribution:

• Hilly areas: 2persons per 1,000 consumers

• Plains: 1 person per 1,000 consumers

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table 8/2-1

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Inv. Plan (₹. Crores)	160,000	185,500	231,000	288,000	355,000	412,500
% increase		15.94	24.53	24.68	23.26	16.2
Manpower ('000)	90	103	127	157	192	221
Manpower Increase (Y-on-Y)		13	24	30	35	29
% increase		14.44	23.3	23.62	22.29	15.1

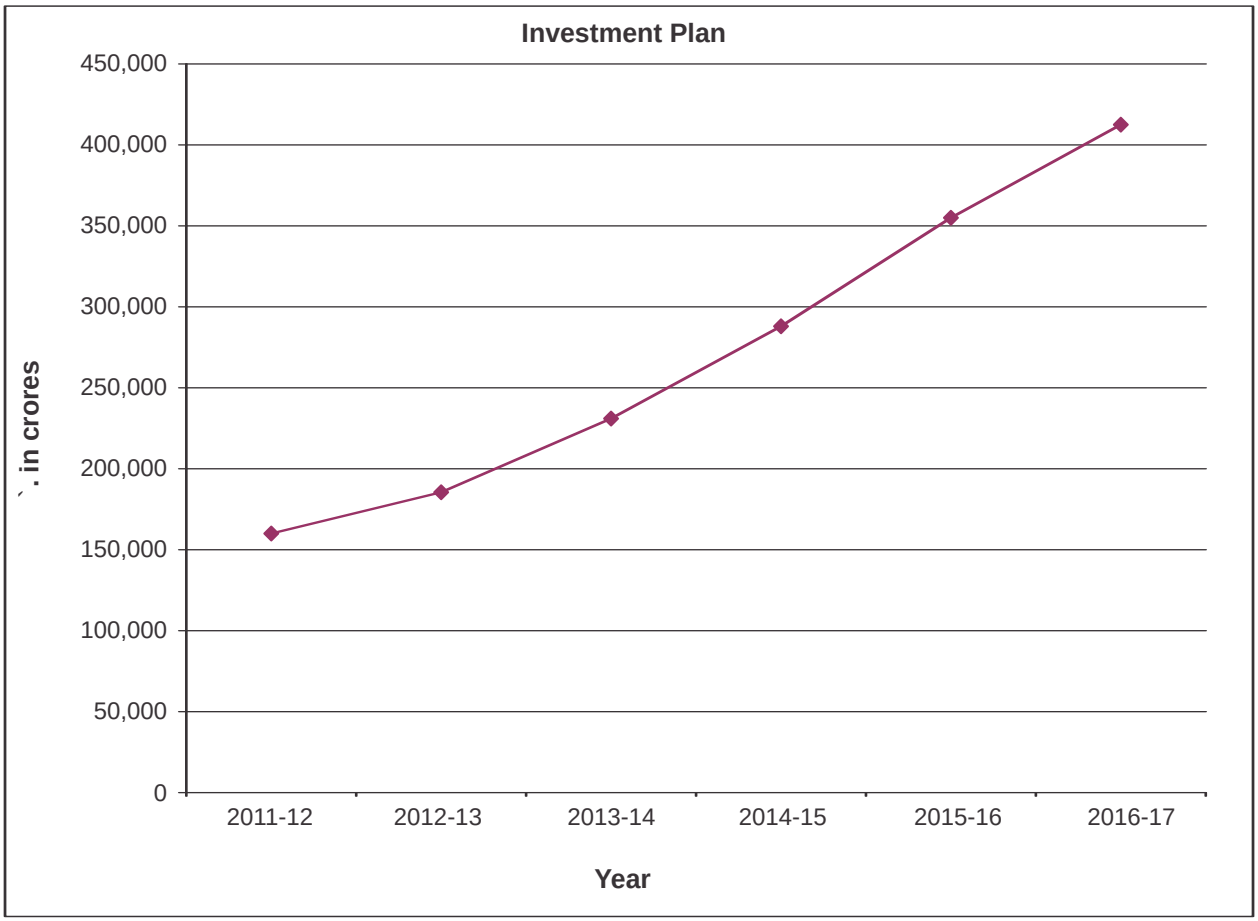


Fig. 8/2-1

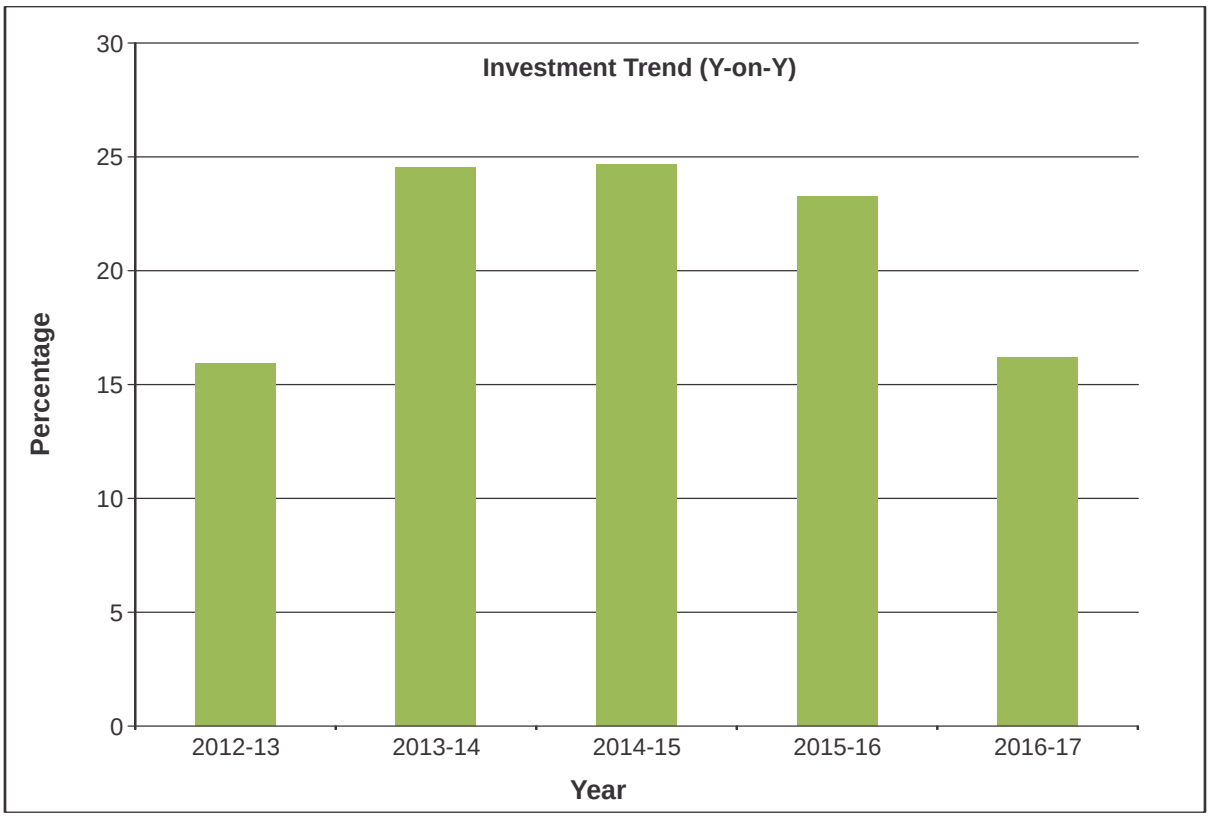
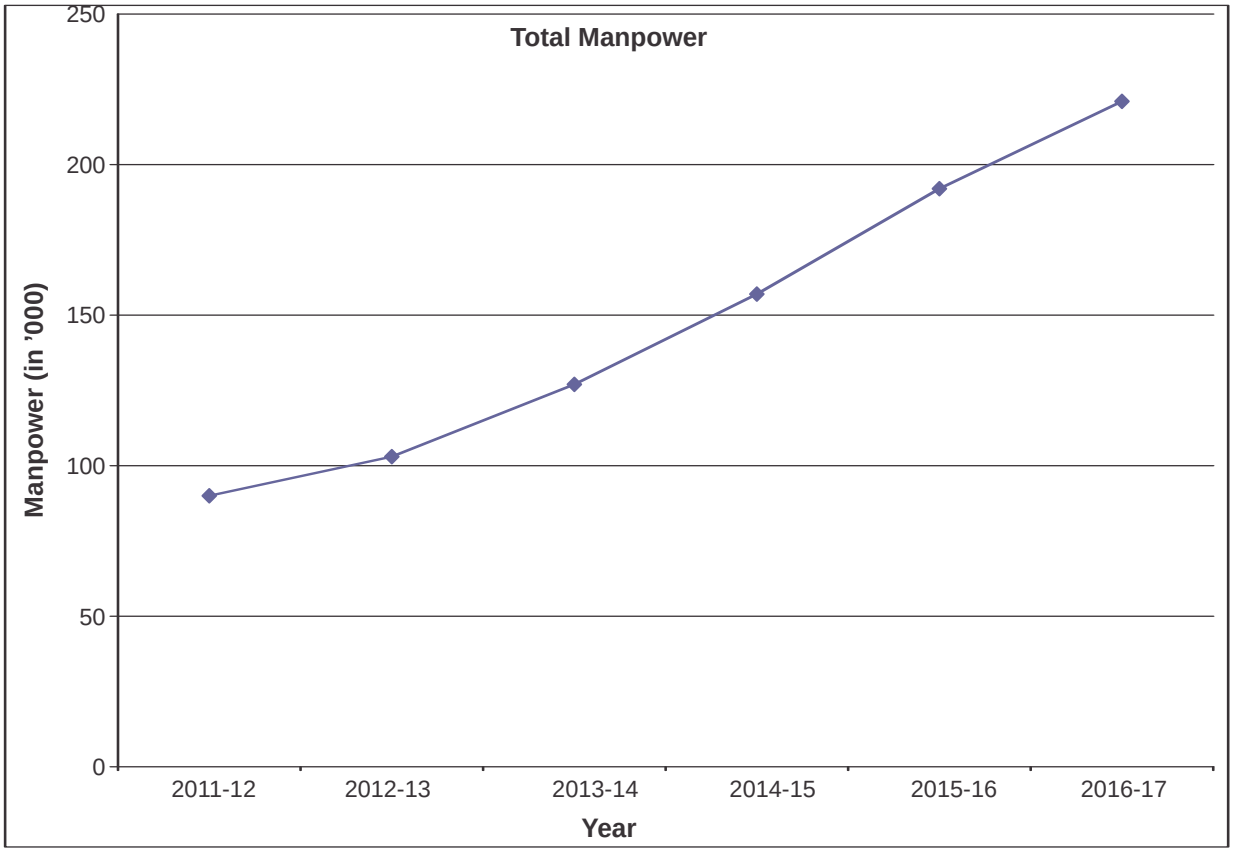


Fig. 8/2-2



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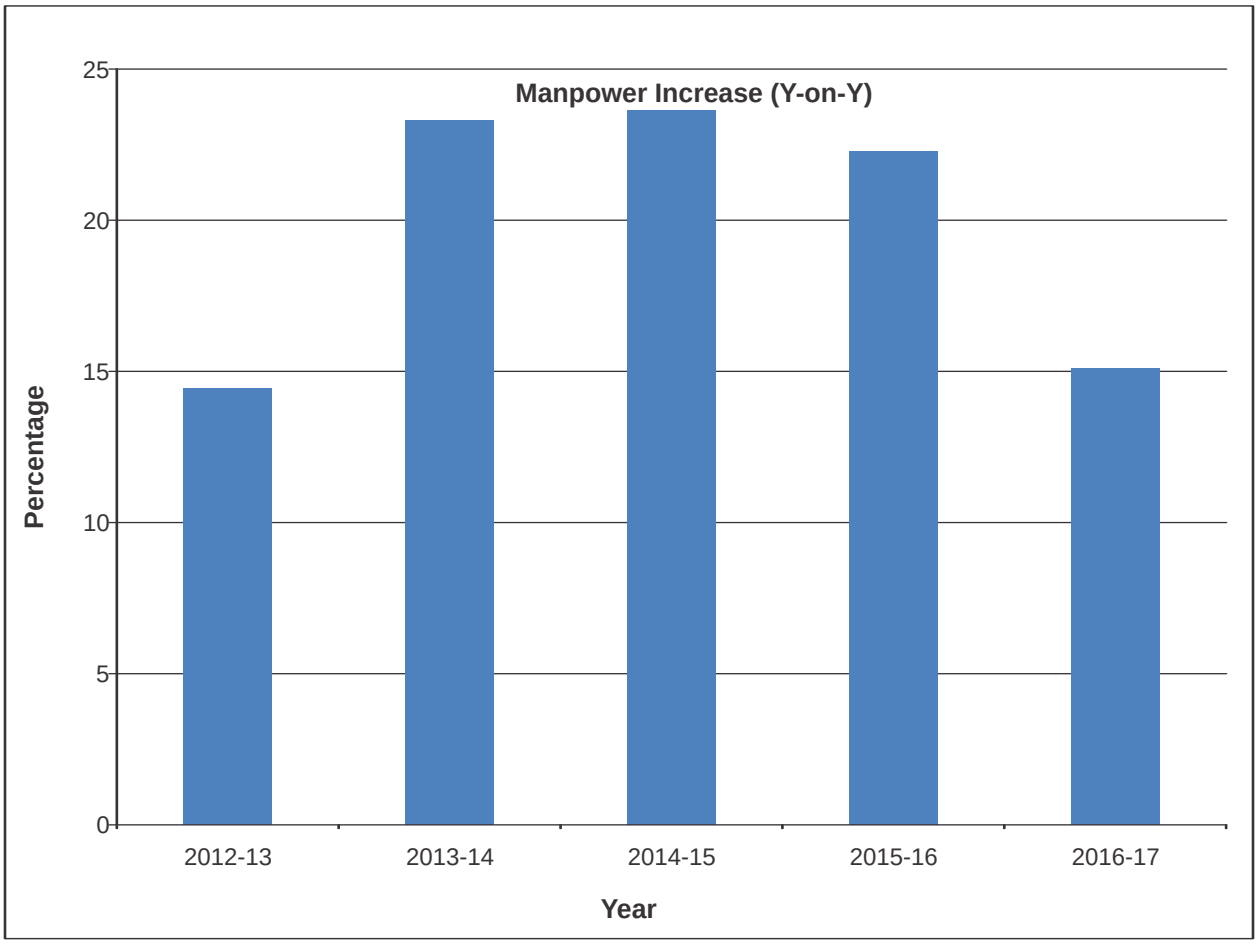

Manpower Increase (Y-on-Y)
Percentage
25
20
15
10
5
0
2012-13
2013-14
2014-15
2015-16
2016-17
Year

Fig. 8/2-4

CHAPTER 9

ENVIRONMENTAL ENGINEERING
(Incl. domestic water supply and distribution)

9.1 Background

Urban population has grown significantly over the past decade and this trend is expected to continue and indeed accelerate. This would involve expanding / upgrading urban infrastructure covering basic civic services such as water supply, sewerage, solid waste management on an urgent basis. Issues relating to environmental engineering are considered in this section.

Government has initiated several schemes to promote an orderly and sustainable process of urbanization for supporting growth and inclusive development. The flagship scheme is the Jawaharlal Nehru National Urban Renewal Mission (JnNURM), started in 2005-06, to provide substantial central financial assistance to 65 mission cities for infrastructure, housing and capacity development. The total investment under this scheme is expected to be around ₹. 3,35,000 crores directed towards Urban Infrastructure and Governance (UIG), Basic Services to Urban Poor (BSUP) and Capacity Building and Institutional Development (CBID).

Water supply and sanitation projects alone would require an annual investment of about ₹. 29,400 crores. Of these, investments in Urban Infrastructure and Governance (UIG) account for over 80% of the total investments under the JnNURM.

9.2 X FYP

Three urban schemes, viz., The Integrated Development of Small & Medium Town Scheme (IDSMT), Mega-cities Scheme and Accelerated Urban Water Supply Programme (AUWSP) were in operation during the X FYP. IDSMT and AUWSP have now been merged with Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), while the Mega-cities scheme was merged with the JnNURM.

IDSMT aims to improve the economic and physical infrastructure, provide essential facilities and services in small and medium towns and slow down the growth of large cities through increased investments in Tier II and III urban areas. In other words, IDSMT facilitates urbanization through distribution of opportunities and facilities. Table 9.1 and 9.2 show the magnitude of the requirements in water supply and waste water treatment during the X FYP.

It is estimated that about 1,15,000 MT of Municipal Solid Waste is generated daily. The tentative outlay for the X FYP period was ₹.18,749 crores in the State sector and ₹.1,330 crores (₹.900 crores for water supply and ₹.430 crores for sanitation) in the central sector making a total outlay of ₹. 20,079 crores against the requirement of ₹.64,803 crores assessed by the Planning Commission. It is evident that there is deficit of ₹. 44,724 crores for the urban water supply and sanitation sector during the X FYP.

Table 9.1 : Status of Water Supply, Waste Water Generation and Treatment Class I Cities/ Class II towns in 2003-04 (during X FYP)[32]

Parameters	Class I Cities	Class II Towns	Total
Number (as per 2001 census)	423	498	921
Population (millions)	187	37.5	224.5
Water Supply (MLD)	29,782	3,035	32,817
Water supply (Lpcd)	160	81	146
Wastewater generated (MLD)	23,826	2,428	26054
Wastewater generated(Lpcd)	127	65	116
Wastewater treated (MLD)	6,955(29%)	89(3.67%)	7044(27%)
Wastewater untreated (MLD)	16,871(71%)	2339(96.33%)	19210(73%)

Table 9.2 : Public and Private Investment in Water Supply and Sanitation during the X FYP[33]

(₹. In crores)

	2002-03	2003-04	2004-05	2005-06	2006-07	Total X FYP
Centre	6,936	7,292	8,470	8,370	11,248	42,316
States	2,520	3,391	3,925	5,217	6,411	21,465
Private	159	357	286	162	57	1,022
Total	**9,616**	**11,040**	**12,681**	**13,749**	**17,716**	**64,803**

9.3 XI FYP

The Mid-term Appraisal, estimates that ₹. 3,00,000 - 4,00,000 crore per year would be required for investment in urban infrastructure in Indian towns and cities; of which the requirement for water supply and sewerage will be around ₹. 2,00,000 crore – 2,50,000 crore (60-65%) per year.

Government of India had launched the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) for cities not covered under JnNURM.

[32] Report of the working group on Urban development, Urban water supply & Sanitation & Urban Environment for the XIIth plan (2007-2012), Ministry of Urban Development, GOI, December 2006

[33] "Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August 2008

Table 9.3 : Projected investment in the XI FYP in Water Supply & Sanitation[34]

(₹. in crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Centre	5,152	6,411	7,991	9,976	12,474	42,003
States	13,500	15,558	18,308	21,995	26,945	96,306
Private	646	812	1,024	1,295	1,645	5,421
Total	**19,298**	**22,781**	**27,323**	**33,266**	**41,063**	**1,43,730**

Table 9.4 shows the urban-rural shares of expenditure on water-supply and sanitation. Of the total investment projected, 63% is allocated to rural water supply and sanitation and 37% to urban water supply and sanitation.

Table 9.4 : Projected Investment in the XI FYP in Rural & Urban Water supply & Sanitation[35]

(₹. in crores)

	2007-08	2008-09	2009-10	2010-11	2011-12	Total XI FYP
Rural	12,567	14,577	17,244	20,791	25,521	90,701
Urban	6,731	8,203	10,079	12,474	15,542	53,029
Total	**19,298**	**22,781**	**27,323**	**33,266**	**41,063**	**1,43,730**

9.4 Looking Ahead

The targets till 2020 are as under:

Table 9.5 : Targets for Water Supply, Sewerage, Solid Waste Management and Drainage[36]

Urban water supply	100% population coverage
Urban sewerage and management	100% population coverage (70% to be provided with sewerage and sewage facilities and 30% with low cost sanitation, septic tanks etc.)
Solid waste management	100% coverage with appropriate Solid waste management facilities
Drainage	100% coverage to provide comprehensive drainage system in towns/cities wherever needed to help control flooding of urban centers, due to rainfall and spilling of sewage on to streets.

[34] "Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August 2008
[35] "Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August 2008
[36] A report on "India – Water Supply and Sanitation: Bridging the Gap between Infrastructure and Service"

9.5 Manpower Projection Until 2020

These targets are to be realized in the light of Millennium Development Goals (MDG's) of which India is one of the signatories. Today India has a total workforce of 26,18,000 for water supply and sanitation. In the field of Public Health Engineering (PHE) it is extremely important for better planning, designing, operation and management of water supply and sanitation facilities in a cost effective and efficient manner.

About 30,600 in-service engineers have been trained under the PHE Training program till 31st March, 2006. More than 1,200 in-service engineers are trained annually in various long term and short term courses. Table 9.6 gives the data for two successive Plan periods.

Table 9.6 : Training of In-service PHE Engineers[37]

Plan period	No. of in-service Engineers trained
IX FYP (1997-02)	6401
X FYP (2002-07)	6500

Scaling up Civil Engineering manpower, at the graduate level, requirement for a typical water supply/sanitation project and projecting nearly double the investment in the sector under the XII FYP from the revised projections of the XI FYP, we arrive at a total additional requirement of 1,79,000 till the end of XII FYP, an annual average increment of 35,800.

[37] Report of the working group on Urban development, Urban water supply & Sanitation & Urban Environment for the XII plan (2007-2012), Ministry of Urban Development, GOI, December 2006

Annex 9/1

Environmental Engineering

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table 9/1-1 : Investment during XII FYP and Civil Engineering Manpower Estimate

Year	2012	2013	2014	2015	2016	2017
Inv. Plan (₹. Crores)	26,559	29000	35000	44000	54000	63,000
Manpower* ('000)	142	154	184	229	278	321
% increase		8.45	19.48	24.46	21.4	15.47

Annex 9/2

Environmental Engineering

Plausible Scenario of Annual Investments During XII FYP and Civil Engineering Manpower Requirement

Table 9/2-1

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Inv. Plan (₹. Crores)	26,559	29,000	35,000	44,000	54,000	63,000
% increase		9.19	20.69	25.71	22.73	16.67
Manpower ('000)	142	154	184	229	278	321
Manpower Increase (Y-on-Y)		12	30	45	49	43
% increase		8.45	19.48	24.46	21.4	15.47

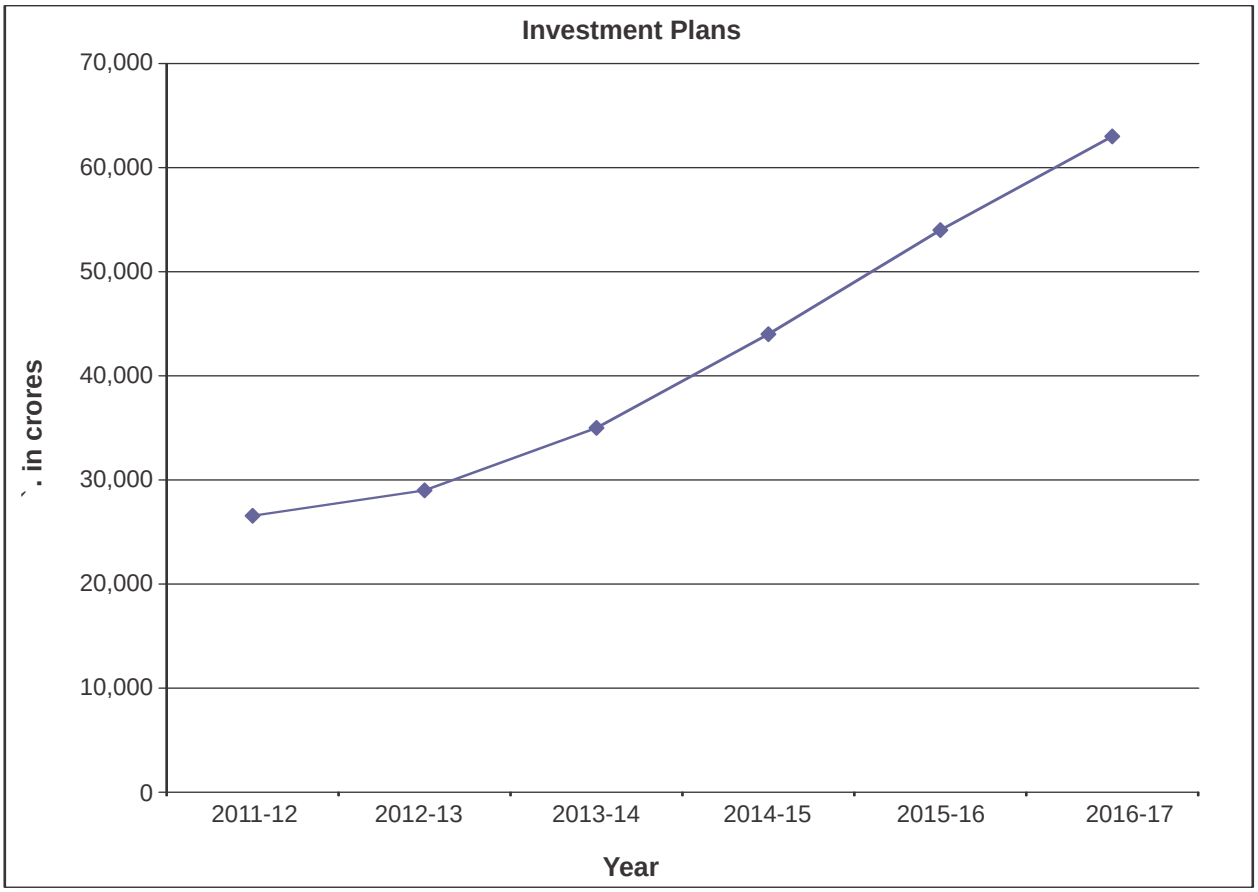


Fig. 9/2-1

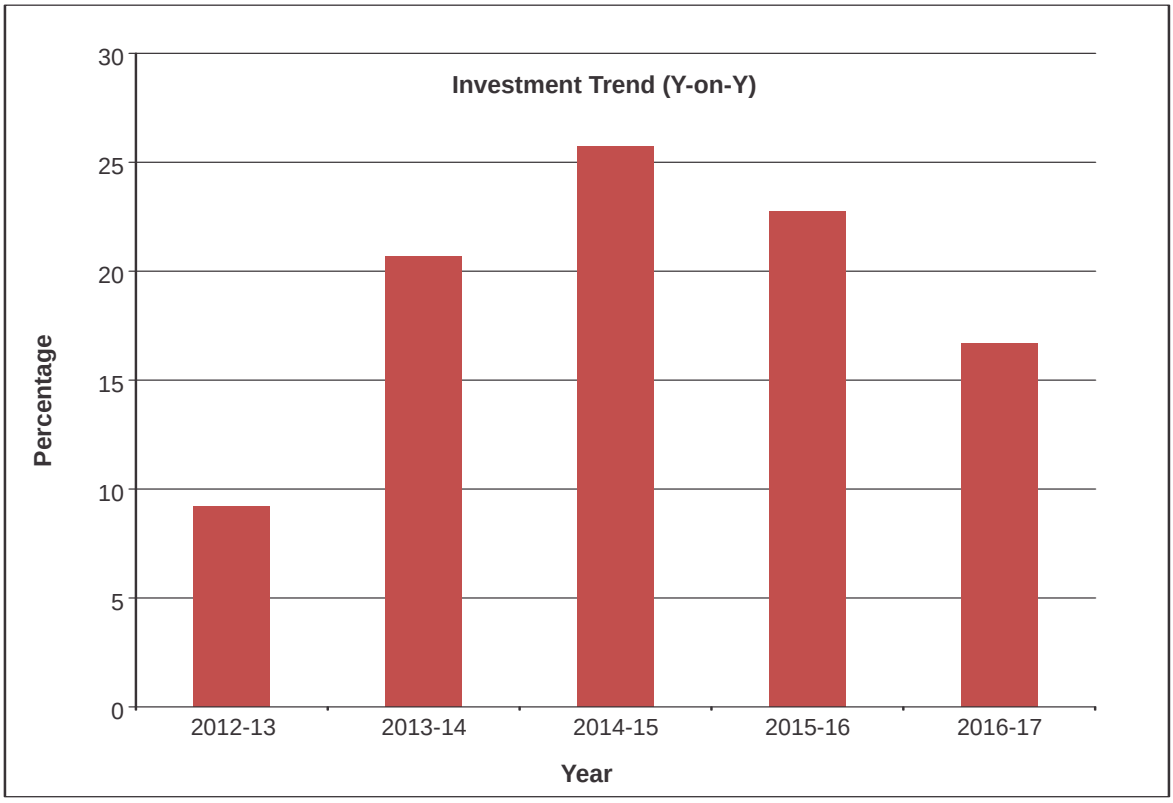


Fig. 9/2-2

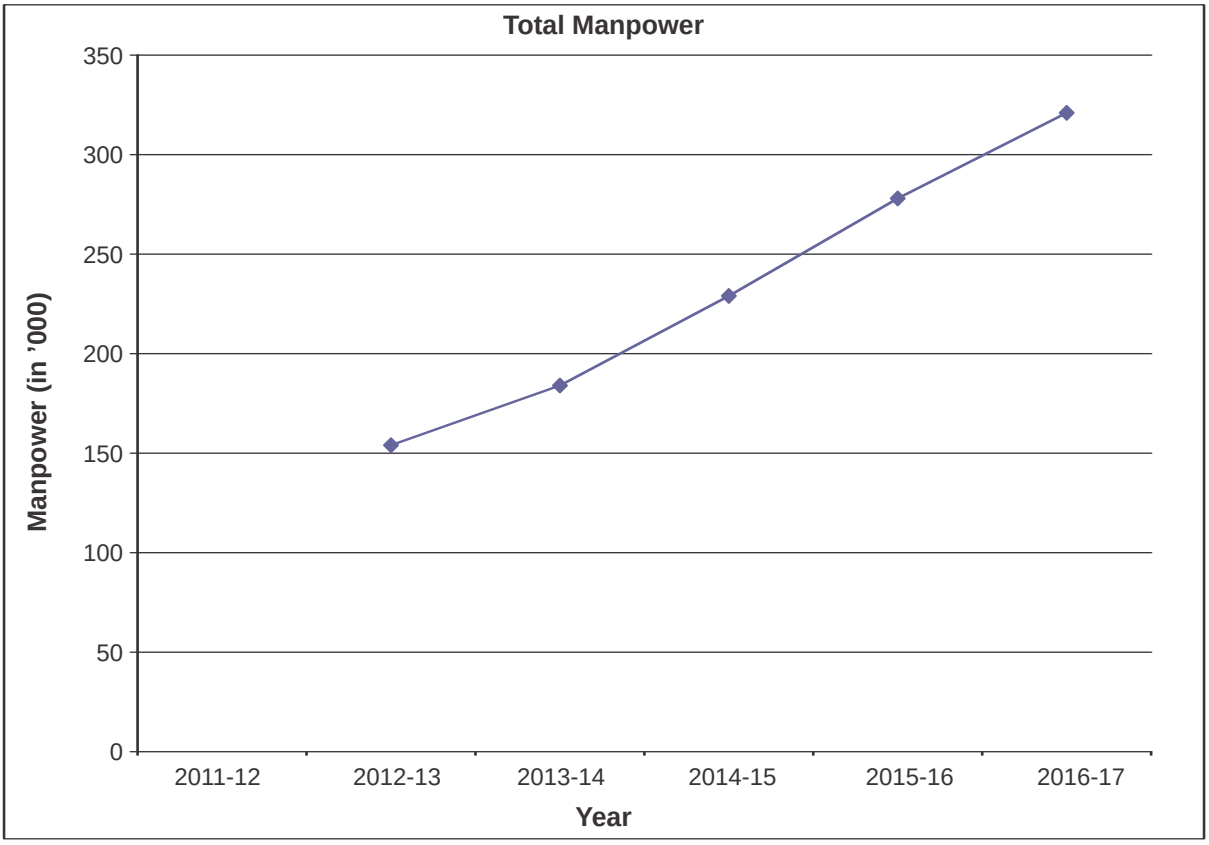


Fig. 9/2-3

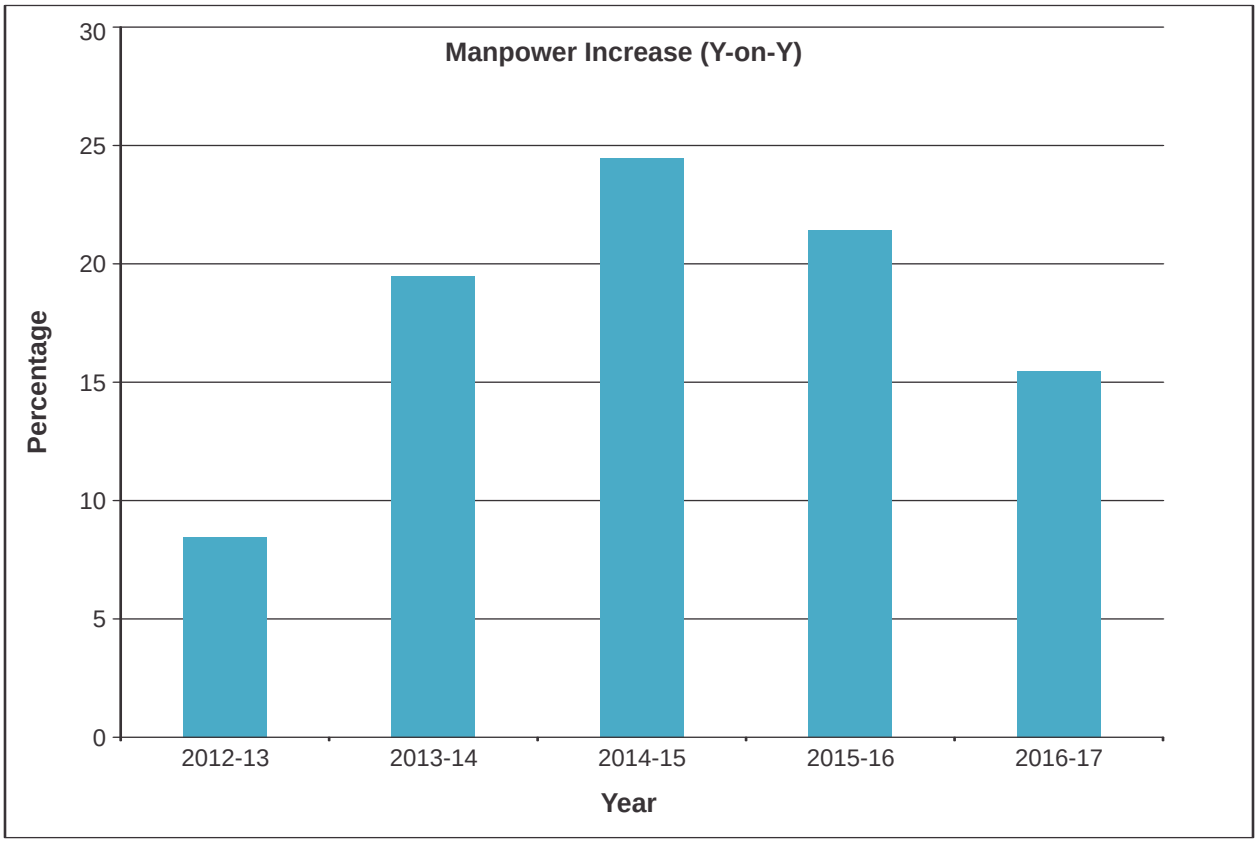

Manpower Increase (Y-on-Y)
Percentage
30
25
20
15
10
5
0
2012-13
2013-14
2014-15
2015-16
2016-17
Year

Fig. 9/2-4

CHAPTER 10

TELECOMMUNICATIONS

10.1 Background

The Indian telecommunication market is the fastest growing in the world and is now the second largest telecom market globally. This has been facilitated by dynamic economic growth, and the relatively shorter gestation period of provision / upgrading.

The massive expansion in the sector, measured by tele-density which is expected to register steeply increasing numbers, augurs well for engineering services including civil engineering. Any urban scenario today shows an unending series of cell phone towers, on the ground as well as on roof tops. The urgency for rural telephone connectivity, on work as the focus in inclusive development would augment the need for cell phone towers in huge numbers, in the rural hinterland. By one estimate, nearly 150,000 towers would be required every two years or so.

Assuming a 80-20 split between roof top (typically 9-12 m tall, at about 2-3 tons per tower) and ground based (30-50 m, at about 12 to 15 tons per tower) steel tower, the steel requirement would be about 810,000 tonnes over two years. Such a growth rate may moderate after about a decade or so, but not earlier. Converting every two years 810,000 tons of steel into standing towers with foundations, and other auxiliary structures across the country would be a massive operation, requiring a huge number of civil engineers, involved in design and construction.

10.2 X FYP

Plan outlays during the IX and the X FYPs, were ₹. 47,280 crores and ₹. 98,968 crores respectively. There has also been a substantial change between mobile vis-à-vis fixed telephones as well as between public and private provider. Against a target of 255 lakh new connections, the private sector added 892 lakh connections. Switching capacity increased from 474.3 lakh on 31.3.02 to 830 million lines including mobile on 31.8.06 for the public sector units. The number of village public telephones rose from 4,68,862 to 5,51,064 during this period.

The public and private investment projections during the X FYP (shown in Table 10.1) were more or less achieved, a performance not seen in any other sector of infrastructure.

Table 10.1 : X FYP Projections for Telecom Sector[38]

(₹. in crore)

SEGMENT	2002-03	2003-04	2004-05	2005-06	2006-07	Total (Anticipated)
Centre	15,690	8,649	9,508	7,957	7,208	49,013
Private	5,954	4,274	8,600	16,642	18,882	54,352
Total	**21,644**	**12,924**	**18,108**	**24,599**	**26,090**	**1,03,365**

By the end of the X FYP, investment by the Centre was ₹. 48,213 crores (47.32%) and the Private sector, ₹. 53,676 crores (52.68%), totaling ₹. 1,01,889 crores.

[38] "Projections of investment in Infrastructure during the 11th Plan", Planning Commission, GOI, 14th August 2008

10.3 Focus of the XI FYP

The XI FYP focused on evolving a strategy for developing world class infrastructure for supporting accelerated growth of all sectors, bridging the digital divide between the urban and rural areas, optimum utilization of spectrum, formulating policy recommendations for facilitating the private sector investment (including FDI) and reviewing the performance of telecom equipment manufacturing sector.

The specific physical targets set during the XI FYP are:

• A telecom subscriber base of 600 million

• 200 million rural telephone connections by 2012, and reaching a rural tele-density of 25

• Telephone connection on demand across the country at affordable prices

• 20 million broadband connections and 40 million internet connections by 2010 as per the Broad Band policy 2004

• Broadband connection on demand across the country by 2012

• 3G services in all cities/town with more than 1 lakh population

• Introduction of mobile TV

• Broadband connectivity to every secondary school, health centre, Gram Panchayat on demand, in two years

• India to be a hub for telecom manufacturing by facilitating establishment of telecom specific SEZs.

The investment requirements, estimated at ₹. 3,45,134 crores, is 34% higher than the amount of ₹. 2,58,439 crores projected at the time of XI FYP formulation. This highlights the evolving nature of the technology, its capability, and its attractiveness to the population. Competition in this sector has been quite intense, resulting in benefits accruing to the economy and the users through improved quality of service at lower costs.

Table 10.2 : Revised Projection of Investment during XI FYP[39]

(₹. in crores)

	X FYP (Actual)	XI FYP (Original projection)	2007-08 Actual	2008-09 Actual	2009-10	2010-11	2011-12	XI FYP (Revised projection)
Central	48,213	80,753	7,894	11,048	13,186	13,988	15,387	61,503
Private	53,676	1,77,686	24,007	41,248	51,019	70,351	97,007	2,83,631
Total	**1,01,889**	**2,58,439**	**31,900**	**52,295**	**64,206**	**84,339**	**1,12,394**	**3,45,134**

10.4 Achievements till date

• India has the second largest network with 562.15 million telephone connections at the end of 2009.

• Total number of broad band connections till date is 7.82 million

[39] Mid-term Appraisal Of the Eleventh Plan Report on Investment on Infrastructure, Planning Commission, GOI, April 2010

• 3G Spectrum - 3G service portfolio includes applications like video SMS, video streaming, mobile TV, ultra high-speed data transfers and route finder

• Several programmes initiated to provide broadband connectivity to every secondary school, health centre and gram panchayat

• During XI FYP the capital investment is around ₹. 830,000 crores. In addition, investments are also flowing into manufacturing mobile handsets.

Key statistics

Table 10.3 : Telecom Subscription Numbers[40]

Total Subscribers	562.07 million
Urban Subscribers	387.62 million
Rural Subscribers	174.53 million
Overall tele-density	47.88
Urban tele-density	110.0
Rural tele-density	21.16

Under Telecom Development and Investment Promotion (TDIP) seven Telecom Centres of Excellence (TCOEs) have been set up in PPP mode in various areas.

10.5 Activities during the Remaining XI FYP Period & Approach towards XII FYP & Beyond

1. Laying of fibre optic cables to uncovered areas, especially rural areas must be completed
2. Smooth launching and seamless progress of 3G
3. Increased productivity and asset usage by pushing innovative value-added services
4. Expansion of rural telephony and rural broadband and, in general, ICT penetration into the rural areas
5. Increase rural tele-density from 21% to 25% by the end of the XI FYP representing 200 million rural connections
6. The Government is planning to make it mandatory for telecom towers to be powered by solar energy. The Ministry of New and Renewable Energy (MNRE) is undertaking a test/pilot project on the adoption of solar power panels on 600 towers which is expected to get completed by 2011

Such infrastructure projects involving tower erection requires active participation of civil engineers in the telecom sector.

10.6 Manpower projection

The Indian telecom sector would provide direct employment to more than 4,00,000 personnel by the end of the XI FYP. While appreciating the success in the telecom sector, we should recognize that there is no room for complacency. Government is now looking forward to setting a target of 600 million telephone

[40] Mid-term Appraisal of the XI Plan Report on Telecom Industry, Planning Commission, GOI, May 2010

subscribers by the end of XI FYP rising to one billion by the end of 2015, Internet and broad-band subscribers will increase to 40 million and 20 million, respectively by 2010-11. The profile of human resource across the telecom industry is given at Table 10.4.

Table 10.4 : Profile of human resource across various educational qualifications[41]

Ph.D/ Research	Engineers	Diploma	ITI and other vocational courses	Other graduates	CA/MBA	XII/X standard
5%	40%*	20%	7%	15%	6%	8%

* The civil engineering component, particularly in the implementation phase may be taken at 2%

In 2008, the size of the telecom equipment industry was ₹. 18,700 crores and it is projected to grow to ₹. 1,35,400 crores by 2022 at a CAGR of 15%.

Table 10.5 : Growth of Telecom Equipment Industry[42]

(₹. in crores)

	2008	2012	2018	2022
Telecom equipment	18,700	47,800	1,33,800	1,35,400

This would imply that the overall employment in the telecom industry would increase from 4,00,000 in 2012 to 7,59,000 by 2022.

Table 10.6 : Employment Growth in Telecom Equipment Industry[43]

	2008	2012	2018	2022	Increment
Telecom equipment industry	1,84,000	4,00,000	8,80,000	7,59,000	5,75,000

Out of the total incremental requirement of 5,75,000 personnel in this sector, the number of engineers of all disciplines to be deployed to meet the projected targets set up to 2022 is 2,30,000.We may peg the requirement of civil engineering professionals at 2% - namely 4,600.

[41] A report on Human Resource & Skill requirements in Electronics & IT Hardware Sector(2022), NSDC
[42] A report on Human Resource & Skill requirements in Electronics & IT Hardware Sector(2022), NSDC
[43] A report on Human Resource & Skill requirements in Electronics & IT Hardware Sector(2022), NSDC

CHAPTER 11

HOUSING, CONSTRUCTION & REAL ESTATE

11.1 Background

Increase in the pace of urbanization promotes demand in the real estate sector as is being witnessed in India these days. As a result, within a short period this sector has transformed itself from a highly fragmented and unorganized entity to a better organized one with a large number of corporates entering the business. The product standards have gone up along with the demands / requirements from the consumer. Simultaneously, the engineering components of real estate initiatives have also gone up along with the size of individual projects.

During the decade 1991-2001, urban population in India increased from 217.6 million to 286.1 million at a CAGR of 2.71%. The XI FYP began with an urban population base of 331.1 million persons and 5,161 cities and towns. And during its tenure, 36.8 million (approx.) persons are expected to be added to the urban areas. Based on the population forecast made by Registrar General, Census Operations, Government of India, the urban population in 2021, is expected to reach 433 million by 2021, while the country's population might reach 1,340 million. Hence the level of urbanization in the year 2021 is expected to be about 32%. This is the population for which we are asked to provide housing and other elements of built-environment within the rubric of real estate. Also by 2030, such urban population would have increased to 590 million, a CAGR of 3.5%.

Apart from population numbers, real estate projections would have to take into consideration the changing face of the economy – focus on and expansion of the service sector. Apart from the increasing urban population, growth will be driven, inter alia, by the IT and ITeS, retail sectors, (with an increase in the demand for office space and higher level of amenities), growing presence of foreign business houses in India, huge strides of Indian corporates and a rapidly spreading consumer class. Real estate activities of Special Economic Zones (SEZs) will also be a contributory factor.

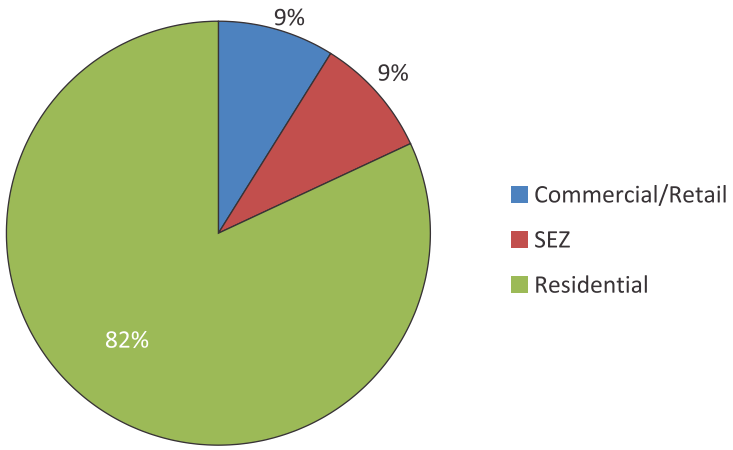


Fig. 11.1 : Segments of Real Estate

The Real Estate sector is estimated to have contributed around ₹. 50,400 crores to the GDP in 2007-08. The market size is estimated to be around ₹. 2,64,300 crores in 2007-08.

Fig. 11.1 indicates the apportioning of real estate under various categories. A brief look at each of the segments follows.

It may be briefly mentioned here that shortage of housing, if any, in rural areas is not very germane to this document as the engineering input in the same, beyond prefabricated housing, will be minimal. That is, in all probability they would fall under the non-engineered category.

11.2 Real Estate for Housing

The residential segment is projected (687 million square feet) during the period 2008-12.Both the National Building Organization and the Deutsche Bank Report forecast new requirements of 1 crore housing units per annum till the year 2030. This is further reinforced by a McKinsey & Company presentation to the Plan Panel clearly outlining a housing shortfall varying from 86 lakh to 138 lakh in the Middle Income Group (MIG) segment.

The structure of Indian families is changing, particularly in urban areas. It is evident that nuclear families are becoming the norm, further exacerbating the deficiencies in the housing sector. The number of nuclear families is estimated to cross 300 million among the middle class population. There is also a growing demand for affordable housing in an enabling environment in urban areas for the poor, which is a priority segment for both the Government and the developers. This is a segment that would require engineering input. Further, "Green" concerns increase the involvement of engineers, particularly civil engineers, in this sector.

The housing sector is estimated to grow at 12% in the long term. Demand for housing is estimated to be around 4.8 million houses per year over the XI FYP period. Apart from new housing units, the demand is also likely to be fuelled by the housing shortages prevalent all across the nation. Such shortage amounts to about 25 million houses during the tenure of the XI FYP.

Table 11.1 : Housing Shortage by State over the XI FYP1[44]

Million houses (% of share of various states)

STATES	Million houses	Share (%) in National Deficit
Andhra Pradesh	1.95	8%
Gujarat	1.66	7%
Karnataka	1.63	7%
Madhya Pradesh	1.29	5%
Maharashtra	3.72	15%
Rajasthan	1	4%
Tamil Nadu	2.82	11%
Uttar Pradesh	2.38	10%
West Bengal	2.04	8%
Delhi	1.13	4%
Other States	5.11	21%

[44] A report on Human Resource & Skill requirements in Building, Construction & Real Estate Industry (2022), NSDC

11.3 Commercial / Retail Construction

The rapid growth of the Indian economy has had a significant impact on the demand for commercial property to meet the needs of business, by way of offices, warehouses, retail shopping centers and the hospitality industry. The size of retail construction is estimated at ₹.11,300 crores and that of office space at ₹.12,600 crores.

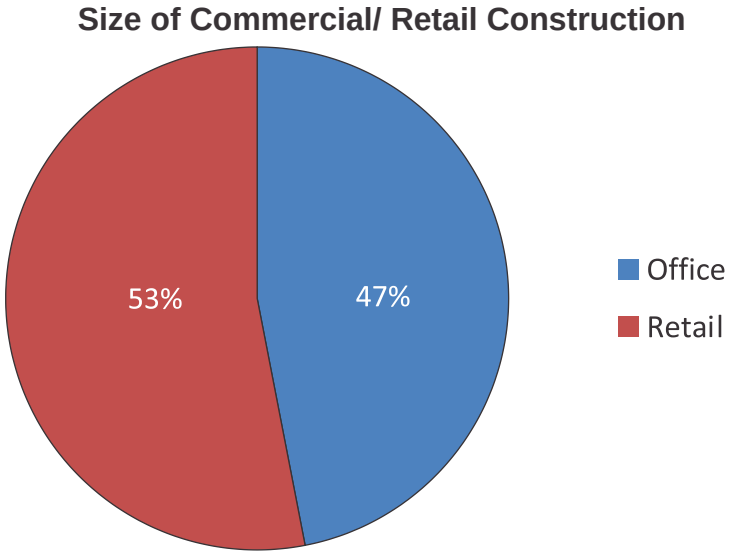


Fig. 11.2 : Real Estate : Commercial and Retail Construction Shares

The demand for office space has been driven by the influx of multinational companies (MNCs) and the growth of the service sector – telecom, financial services, IT and ITeS etc., which accounts for the maximum demand of commercial office space in the country. Growth in IT/ITeS sector is estimated at 30% annually. Investments in commercial construction are expected to grow faster than those in housing mainly due to the spurt in office space construction driven by IT/ITeS industry.

The retail segment is a small proportion of the total real estate industry in India with a size of ₹.11,300 crores. The segment is dominated by unorganized retail space providers. In the organized retailing segment, demand for good quality mall space has grown with the entry of international retailers in India and is expected to grow at a CAGR of 19% over the next few years.

11.4 Special Economic Zones

Over the next five years, growth in investments in Indian Industry will be driven by strong capacity additions, led by rapid growth in demand and high existing operating rates. Special Economic Zones (SEZs) will be at the forefront of this growth.

Formal approvals have been granted to 574 SEZ proposals as of March, 2010. Currently there are 350 notified SEZs; 150 SEZs are approved out of which 85 SEZs are in the IT/ITeS segments and 10-15 SEZs in the electronics segment. 130 SEZs, developed by real estate developers, constitute about 50% of the total. 150 approved SEZs would result in investment of ₹.45,000 crores to ₹.54,000 crores immediately.

The SEZ Policy allows usage of a maximum of 50 per cent of the SEZ area as non-processing zone, offering significant potential for residential and support infrastructure.

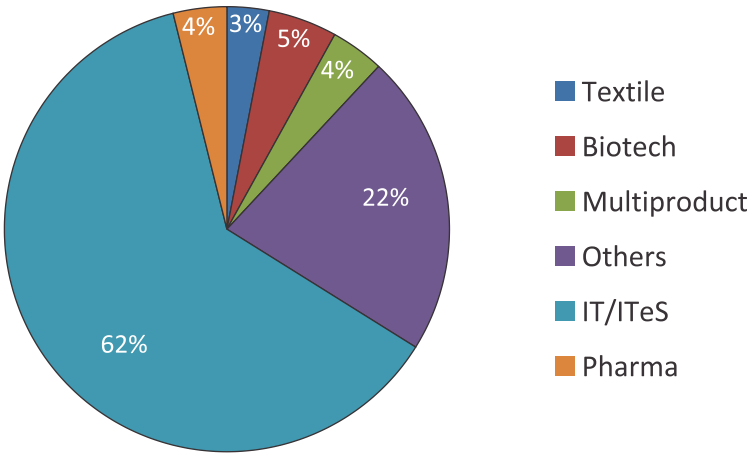


Fig. 11.3 : Industry–wise Classification of Formally Approved SEZs

11.5 Future of Real Estate Industry (XII FYP & Beyond)

Opportunities for growth in the real estate sector in the years to come lie in housing, commercial and retail segments, hospitality, education and health sectors and also in logistics and warehousing. These will be supported by expanding domestic and international trade, aspirational demands of the middle class, tourism requirements etc. It is expected that the doubling of the infrastructure investments in the XII FYP would raise real estate demands to a similar extent and for catering to the same, we need to augment the Civil Engineering workforce.

11.6 Projected Increment in Manpower until 2022

Construction industry in India provides a big opportunity for direct and indirect employment to a wide range of skilled and unskilled persons. The industry employs more than 1.3 crore people[45], many of them women and migrants. It has been growing at more than 10% per year over the last 5 years and covers rural and urban infrastructure, roads, airports, seaports, commercial and residential buildings. Construction has huge possibilities for creating employment which needs to be fully exploited.

The housing sector is likely to generate 40 lakh new jobs within ten years. Based on the growth of the Real Estate sector at 35%, it is expected this industry would reach ₹. 8,10,000 crores by 2020 and the incremental human resource requirement between 2008 and 2022 will be about 1.4 crores.

Table 11.2 : Human resource Demand in the Real Estate Sector[46]

Year	2008	2012	2018	2022	Incremental
Employment	1,07,90,000	1,45,15,000	2,06,92,000	2,49,81,000	1,41,91,000

It is estimated that we need 55,000 graduate civil engineers to be inducted into the industry over the next 10 years.

[45] Report of the working group (setup for preparation of XI FYP) on labour force and employment projection, GOI, Planning Commission, New Delhi, September 2008
[46] A report on Human Resource & Skill requirements in Building, Construction & Real Estate Industry (2022), NSDC

Annex 11/1

Housing, Construction & Real Estate

Presented here in are the details as regards the Civil Engineering manpower requirements in the last section of Chapter 11 – Real Estate Sector. Today the size of real estate sector is ₹. 2,64,300 crores and by 2020, it projected to reach ₹. 8,10,000 crores.

A typical housing project worth ₹. 550 crores comprising 5,000 dwelling units and an execution period of 3 years, requires 70 graduate civil engineers ie., 15 civil engineers at the designing stage, 45 during execution and 10 from client's side. However, for commercial projects the input may be lower given the typical profusion of high-value components. The above numbers may then be reduced by a factor of 0.75 as a composite figure. Hence, 55 graduate civil engineers may be needed for realizing an investment of ₹. 550 crores.

On the basis, we need 55,000 graduate civil engineers over a period of 10 years for the projections regarding the growth of the real estate sector.

CHAPTER 12

BUILDING & CONSTRUCTION MATERIAL INDUSTRY
(Including Cement & Steel)

12.1 Introduction

The current size of the construction industry is estimated at ₹. 310,000 crores (including Public and Private Investments), with an employment status of 3.1 crores man-years/year. The conscious thrust in the Five Year Plans for improving the state of physical infrastructure has led to a rapid surge in the work load, and the sector grew at the rate of more than 10 % annually during last five years. A gross estimate of the requirements of construction materials for execution of planned infrastructure development is as under:

Total investment for construction industry - ₹.14,56,000 crores

Monetary requirement for construction materials - ₹.4,95,000 crores[47]

About 250 industries, both major and ancillary, such as cement, steel, brick, timber and building materials are dependent on the construction industry. A unit increase in expenditure in this sector can generate a fivefold increase through the multiplier effect on income. As most of the materials are either manufactured locally, (in cottage or small scale industry), accurate and reliable data are not available for quantifying the exact nature of linkages with the construction industry. On the other hand, linkages of products such as paints and petro-products are difficult because of their stronger linkages with other sectors. In case of cement and steel, however (almost) 100% of cement production and 40-60% of steel production are utilized for construction.

A Construction Industry Development Council (CIDC) Survey on the components of construction costs, shows that construction materials constitute the bulk of the cost, followed by construction equipment.

Table 12.1 : Construction Cost : Percentage Cost of Construction Materials and Equipments[48]

	Construction Materials	Construction Equipment
Building	58-60%	4-5%
Roads	42-45%	21-23%
Bridges	46-48%	16-18%
Dams, etc	42-46%	21-23%
Power	41-43%	21-24%
Railways	51-53%	6-8%
Mineral Plant	41-44%	20-22%
Medium Industry	50-52%	7-9%
Transmission	49-51%	5-7%

[47] Planning Commission Working group report on Construction for the 11th Five year plan
[48] Construction Industry Development Council Survey (CIDC Survey)

12.2 Trend Analysis in the Past and Performance Now

The following table shows the trends in the performance of industrial sub-sectors (some of the construction materials) :

Table 12.2 : Performance Trend of Certain Industrial Construction Materials[49]

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	CAGR 2002-07
Wood & wood products	-11.03	-17.6	6.8	-8.4	-5.7	29.1	-0.39
Chemical products	4.76	3.7	8.7	14.5	8.3	9.4	8.86
Rubber, plastic, petroleum	11.08	5.5	4.5	2.4	4.3	12.7	5.81
Non-metallic mineral products	1.37	5.1	3.7	1.5	11.0	12.9	6.75
Metals & alloys	4.01	9.2	9.2	5.4	15.8	22.9	12.32
Metal products & parts	-9.59	6.4	3.7	5.7	-1.1	11.4	5.14

The current delivery capability of construction industry, estimated at ₹. 3.10 lakh crores per year, is based on the consumption of Cement and other important constituents. Hence, the industry would need to enhance the deliveries substantially to meet the additional investment target of more than ₹. 14 lakh crores. The key focus should, therefore, be on enhancing the building capabilities of the construction industry to deliver the desired results for coping with the enlarged work plans and executing the infrastructure projects in time.

12.3 Mining Industry

An expanding Indian economy needs rapid development of the mining sector, for meeting its requirements. Significant inputs from Civil Engineering, particularly environmental engineering are needed for this sector.

Continuous efforts for locating new minerals resources over the past 55 years have led to higher estimated reserves for various minerals such as mica, barites, chromite (metallurgical), coal (thermal), lignite, bauxite (metallurgical), manganese ore, and iron ore, and have placed the country amongst the top 10 producers of these minerals. Total alumina capacity increased from 2.72 million tonnes in 2001–02 to 4.24 million tonnes in 2006–07. Production of aluminum increased by 65% during the Plan period, the bulk of the increase being absorbed domestically. NALCO, a Central Public Sector Enterprise has about 35% share of production. Some relevant data on Non-ferrous metals - eg. aluminum, copper, zinc and lead—based on the XI FYP Working Group Report on Mineral Exploration and Development, are given below. Strong growth in domestic demand is expected for all non-ferrous metals, but the country will remain a net exporter of aluminum and copper (based largely on imported mineral concentrate). It will become self-sufficient in zinc but will be a net importer in lead.

[49] Central Statistical Organization

Table 12.3 : Production / Import / Export of Few Important Minerals[50,51]

(in Thousand MT)

	Aluminum		Copper		Zinc		Lead	
	2006-07	2011-12 (E)	2006-07	2011-12 (E)	2006-07	2011-12 (E)	2006-07	2011-12 (E)
Production	1,152.53	1,250*	641.70	705	380.94	638	44.55	95
Import	120	270	-	-	2	-	152	273
Export	200	300	300	219	-	11	-	-
Domestic demand	920	1280	440	589	455	667	275	443

Note: Demand for copper for 2011–12 has been projected at 6% compound growth rate per annum and production at 90% capacity utilization of existing installed capacity of 8,97,500 tonnes.

*Excluding additional capacity of 2,50,000 tonnes from Vedanta Aluminum Limited (VAL) at Jharsuguda, which is under trial run

Table 12.4 : Production of Selected Minerals[52]

(in '000 tonne)

Item	2006-07	2009-10 (April-Dec)
Iron ore (in million tonne)	187.70	156.00
Bauxite (in 000 tonne)	15,733	10,388
Chromite (in 000 tonne)	5,296	2,524
Manganese (in 000 tonne)	2,116	1,686
Copper ore (in 000 tonne)	3,271	2,302

Timber

As per the report of the International Tropical Timber Organization, (May 2004) the production trend of timber product, till 2000 is given in the following table:

Table 12.5 : Production Trend of Timber Products[53]

	1998	1999	2000
Various kinds of wood (in cubic meter)	7,98,57,000	53,24,64,000	34,98,49,000

Consumption trend of timber products is presented below. Figures quoted are from the report of the International Timber Trade Organization.

[50] Working Group Report on Mineral Exploration and Development (other than coal and lignite), Eleventh Five Year Plan, Volume III.
[51] Mid-term appraisal report on Industry, Planning Commission, GOI
[52] Mid-term appraisal report on Industry, Planning Commission, GOI
[53] FAO Year book, Forest products, various issues and updates

Table 12.6 : Consumption Trend of Timber Products[54]

Items	1998	1999	2000
Industrial Round Wood	25,709	25,137	24,278
Sawn wood	8,402	8,399	7,904
Veneer	19	18	20
Plywood	331	325	314

Consumption of timber and timber products is increasing because of the increase in population, urbanization as well as standard of living. The major sectors of domestic consumption of timber are housing and furniture manufacturing. The Forest Survey of India in their study "Timber and Fodder from Forest, 1996" had projected the demands for 2001 and 2006 as follows:

Table 12.7 : Timber Demand Projections from 2001- 2006(million cubic meter)

Category of use	Year 2001	Year 2006
Housing and allied domestic industry	39	43
- Rural	31	34
- Urban	8	9
Furniture	10.4	11.6
- Rural	6.3	7
- Urban	4.1	4.6

FSI had also carried out a demand-supply exercise in respect of timber, the results are summarized below:

Table 12.8 : Demand and Supply of Wood (million cubic meter)

Particulars	2001	2006
Wood requirement for housing, furniture, agriculture implements	73	82
Output from forests	12	12
Outturn from plantations, social forestry schemes and other wood lots	47	53
Deficit	14	17

There is evidently a big shortfall between availability (domestic supply) and requirement (demand) of timber in India and this is likely to increase in future. To bridge the gap between demand and supply the Planning Commission had set a target of 33% land to be brought under forest cover by 2012 (end XI FYP). Investment requirements for the next twenty years to bring 33% land under forest cover, including afforestation of both forest and non-forest lands are to the tune of ₹. 5,300 cr.

[54] Report of the International Timber Trade Organization

Glass

The Glass industry in India is worth (in 2010) around ₹.18,000 crore, and achieved an annual growth rate of 10-12 per cent over the past five years. This is because of increase in demand from user-industries like infrastructure, construction, automobiles, food processing, beverages, pharmaceuticals and cosmetics. Glass is used widely in solar products, and for energy conservation. The industry is diversifying into interior decoration, furniture, murals and other value addition areas to promote growth. Today, glass is not just a means of letting light into a space and achieving protection from the elements, but a statement of style, awareness and an expression of the designer and the client's ideological stand on the environment.

The growth of the industry is dependent on construction and architecture activities. The automobile sector is still a big user of flat glass. The construction sector is the largest consumer of float glass and uses around 60% of the total production. Real estate is the biggest consumer of flat glass for windows, doors, partitions and a host of other applications. Increasing disposable income and willingness to spend on better living standards due to rising aesthetic sense among consumers are facilitating the growth of the sector.

The majority of raw materials required by the industry are available locally, providing excellent scope for growth and development.

Exports

There was a significant spurt in export of glass and glassware from ₹. 157.5 cr in 1993-94 to ₹. 900 cr in 2002-03 and ₹. 1021.5 cr. in 2003-04. Products to achieve strong export growth in 2004-05 were glass fibre, ophthalmic lenses, glass lampware, containers, bangles, table / kitchenware, mirrors, glass beads and false pearls. Export shortfalls were recorded for vacuum flasks and refills, unworked sheet glass, vials, float glass and scientific glassware.

Special glasses

Technology for developing optical glasses is guarded the world over. CSIR established its first glass manufacturing unit at CGCRI and has developed more than four hundred different types of special glasses for use in mirrors in telescopes, reflectors in satellites, tracking robot movement, radiation shielding glasses to provide protection from harmful radiations. These are being customized to meet the requirement of strategic sectors such as space, atomic energy etc.

12.4 The Road Ahead

The awareness for advancements are many and some are listed below:

1. Materials

Potential advances that are expected in the materials area are likely to be in the use of (i) HVFA concrete; (ii) supplementary cementing materials like GGBS, metakaolin, silica fume, and rice husk ash; and (iii) fibers for making high strength high performance concrete. Self-compacting concrete is expected have an important role in future construction in India.

2. Production

The construction of cement production plants and concrete production facilities is on the rise. The production of cement is expected to have a growth rate of 10% in the coming years. Higher utilization of fly ash, GGBS and other supplementary materials is likely in making quality concrete.

3. Quality Assurance Practices

The quality of construction is likely to be enhanced significantly by the use of sophisticated construction machinery, batching plants, and Ready-Mix Concrete (RMC), self-compacting and high performance concrete.

4. Design Practices

It is expected that designers will follow the current and future codes of practices based on the actual conditions prevailing at a particular site.

5. Construction Practices

The construction industry is likely to benefit in several ways by the advantages Ready-Mix Concrete (RMC) offers, such as a supply of quality concrete, speed in construction, reduction of pollution and congestion at construction sites, durable construction, and overall economy. Besides cement companies, even private entrepreneurs are entering Ready-Mix Concrete business in a big way.

6. Maintenance of Existing Facilities

With so many large-scale projects coming up, it is essential to settle guidelines for the maintenance of existing structures.

12.5 Cement and Steel

Per capita consumption of steel and cement is considered to be a reliable indicator of the development scenario in any country. On both these counts, India is very much below the curve of the developed countries. While china is closing the gap between the developed countries and itself, India has not accelerated itself to the extent needed.

Cement and steel production in India are going up quite rapidly. This is a good indication for an increased intake of Civil Engineering professionals in various upstream industries catering to infrastructure demand.

The demand for civil engineers in manufacturing cement and steel is assessed in the subsequent sections.

CEMENT

12.6 Background

Infrastructure, industrial investments, and real estate requirements drive the demand for cement. The key drivers are: a buoyant real estate market, increase in infrastructure spending, various government programmes viz the National Rural Employment Guarantee Programme, low cost housing in urban and rural areas under schemes like JnNURM and Indira Aawas Yojana. Demand for cement has been worked out on the basis of observed relationship between cement consumption and selected macro economic variables.

The housing sector accounts for 50% of total cement demand, infrastructure projects 25% and industrial projects 25%. With the Plan investment in infrastructure during the XII FYP touching ₹. 46,12,500 crores, cement production is bound to increase significantly.

India is the world's second largest producer of cement with a total capacity of 224 million tones (MT) (as on April 30, 2010).

12.7 Performance of Cement Industry during X FYP

Cement production during the X FYP almost matched the target and deficiencies, if any, were nominal. This goes to the credit of both the planners and the industry. Table 12.9 shows the performance of the cement industry vis-à-vis the X FYP.

Table 12.9 : X FYP Performance[55]

(In MT)

Year	Capacity Installed	Production Capacity	Demand
2002-03	151.17	116.35	112.59
2003-04	157.74	123.50	119.86
2004-05	165.39	133.57	129.08
2005-06	171.34	147.81	141.56
2006-07	174.99	162.00	152.00

12.8 Cement Production on XI FYP

XI FYP worked under a scenario of annual 9% GDP growth rate, translating into a cement demand growth rate of 11.5% per year. Distributed across various sectors, the cement produced would be required to construct 20 million houses for rural and urban population, 9,500km of roads for NHAI connecting metros, 7,300km of roads for East-West and North-South corridors and so on. There cannot be any development without cement.

The XI FYP projection for additional cement production envisages 73% from greenfield plants and 27% through brownfield expansion / technology upgrade. Either of the above two options involves extensive Civil Engineering inputs. Further, Civil Engineering structures in cement plant involving chemical reactions would be exposed to severely corrosive environment, increasing maintenance demands to be met through Civil Engineering contributions.

Cement capacity and production by the end of XI FYP are estimated to be 320 MT and 269 MT per annum, respectively, at a capacity utilization ratio of 90 percent. An investment of ₹. 52, 400 crores was required to reach the targets. The total installed capacity and the production capacity attained during the XI FYP is given below in Table 12.10.

[55] Report of the working group on Macro overview of the Cement Industry, Planning Commission document, June 2006

Table 12.10 : Production during the XI FYP[56]

(in MT)

YEAR	INSTALLED CAPACITY	PRODUCTION CAPACITY
2007-08	209.40	174.32
2008-09	217.8	181.42
2009-10	224	-
2010-11	269.07 (E)	-
2011-12	320 (E)	269

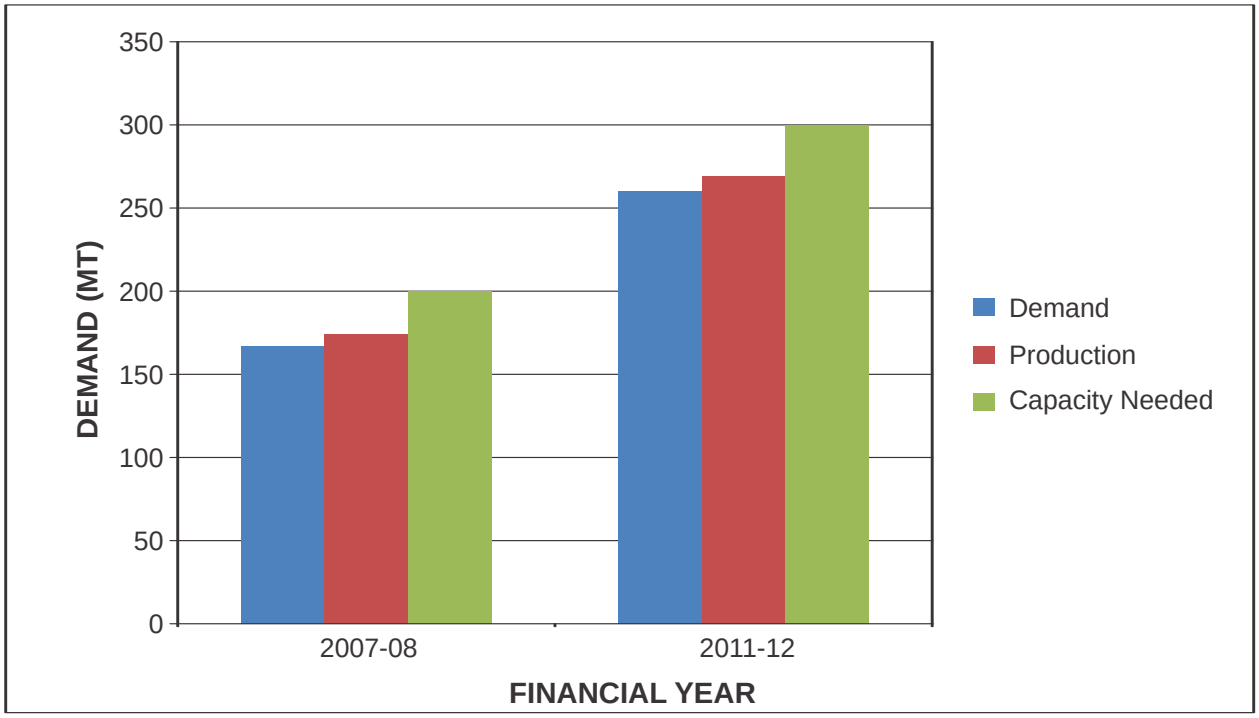


Fig. 12.1 : Cement Demand during the XI Plan - GDP Growth at 9%

It is estimated that cement consumption would be about 200-208MT by the end of 2010 and 315-325MT in 2015. This would result in a realistic per capita consumption of approximately 175kgs.

12.9 New projects and Investment for the XII FYP and beyond (Until 2020)

As per the forecast by Cement International (Vol.5/2005), cement capacity would increase by 400MT by the year end 2020. This appears to be a tight fit with the projected requirement based on the plan to invest ₹. 46,12,500 crores during the XII FYP. The projected growth of the industry by 2022 in terms of production is at a CAGR of 7.4% (Table 12.11), noting that XI FYP called for a CAGR in demand of 11.5%.

[56] Basic data from CMA & Future estimates by the 11th Planning Commission Working group Report- Cement

Table 12.11 : Size of Cement Industry[57]

Year	Cement production (in MT)
2012	269
2018	398
2022	532
CAGR	7.4%

12.10 Manpower demand for the XI FYP and Forecast up to 2020

Cement plants are capital intensive and require a capital investment of more than ₹. 5,000 - 5,500 for per tonne of cement which translates into an investment of ₹. 500 crores for a 1MTPA green field facility. Generally, in a one million tonne per annum (MTPA) modern cement plant, around 400 skilled technical manpower is required, out of which around 150 will be at managerial and supervisory levels. The cement industry today has a total workforce of 1,50,000 and will require an increment of 55,000 manpower by 2020 totalling up to 1,95,000. Currently, 70% (ie., 1,05,000) of the workforce are employed for cement plant construction and cement manufacturing which involves a lot of civil work. Taking into account, various upcoming infrastructure projects, it is estimated that the industry will require a total of 34,400 skilled technical manpower and 40,000 unskilled workers for 86 MT Greenfield expansion, 4,800 skilled technical manpower for 32 MT brownfield expansion and 4,000 skilled technical manpower for 2,000 MW captive power plant operation.

By 2020 the industry should have a total of about 43,000 technical manpower and the incremental human resource (graduates & diploma holders) required would be 13,700 (5,500 graduates & 8,200 diploma holders); of which, it is estimated that 30% would be Civil Engineering professionals. Hence, cement production, setting up the facility and beyond, would require, on an average, 400 graduate civil engineers to be added annually to the industry over the next 10 years. The peak may be taken at about 650.

STEEL

12.11 Introduction

India is now the 5th largest crude steel producer in the world and the largest producer of sponge iron. As per official estimates, the Iron and Steel Industry contributes around 2 per cent of the Gross Domestic Product (GDP).

Construction is already the largest single steel-consuming sector, accounting for around 40-60% of India's steel demand. The construction sector and, in particular, project construction (relating to development of infrastructure) is a crucial demand driver for the steel industry. This is because, construction expenditure not only drives demand for long products, such as bars and structurals; but also increases demand for flat products via water supply works, sanitation, and irrigation projects. The scope for raising the total consumption of steel is huge, given that per capita finished steel consumption is only 44 kg – compared to approximately 180 kg the world over and 320 kg in China. The National Steel Policy has a target for taking steel production up to 110 MT by 2019-20. Nonetheless, with the current rate of ongoing greenfield and brownfield projects, the Ministry of Steel has projected India's steel capacity to

[57] Annual Survey of Industries (ASI), ECE Vision 2015, and IMaCS Analysis

touch 124.06 MT by 2011–12. India's steel capacity is likely to be 293 MT by 2020. An investment worth ₹. 8,80,000 crores is likely to go into the steel sector by 2020[58].

On the consumption side, our per capita numbers are way below those of the developed countries. One reason could be the focus on concrete construction in the housing sector and other real estate projects. However, we must note that the balance is shifting more towards steel construction, given the positives on pace of construction, quality, higher strength etc. Hence, it can be reasonably expected that the demand for steel will grow at not any significantly slower rate than that for cement.

12.12 Performance during the X FYP

The X FYP witnesses robust growth of the steel industry with significant increases in both production and consumption. Crude steel production grew at the rate of 9.8% annually; from 34.83 MT in 2002–03 to 50.88 million tonnes in 2006–07. Such growth was driven by both capacity expansion (from 40.41 million tonnes in 2002–03 to 56.84 million tonnes in 2006–07) and improved capacity utilization (from 86% in 2002–03 to 89% in 2006–07). The year-wise production, availability, consumption, export, and import of finished steel in the X FYP are given in Table 12.12. The average increase in production during the X FYP was 3.7 million tonnes per annum compared to just 1.1 million tonnes per annum in the IX FYP (1997–2002).

Table 12.12 : Production & Consumption of Finished Steel in the Xth FYP[59]

(In MT)

	2002-03	2003-04	2004-05	2005-06	2006-07
Production for sale	35.41	38.58	40.05	44.544	55.416
Domestic availability	28.7	31.2	34.5	39.4	43.7
Consumption	28.6	31.1	34.3	39.1	43.7

12.13 XI FYP Outlay

It is estimated that India will become the world's second-largest steel producer by 2012, the final year of the XI FYP, with a capacity of 124 million tonnes (MT) as part of the push being given to assist overall infrastructure development. Looking further into the future, India's steel production capacity is expected to be nearly 276 MT by 2020 at a CAGR of 13%. For the XI FYP (2007-12), the Planning Commission has approved a total outlay of ₹. 45,607.08 crores.

Demand for steel has been worked out on the basis of observed relationship between steel consumption and selected macro economic variables under four scenarios of GDP growth (i.e., of 7%, 8%, 8.5% and 9%) by 2011-12 as envisaged in the Draft Approach paper for the XI FYP (fig 12.2). In the 'Most Likely' scenario of 9.0% GDP growth, demand for steel works out to be 70 million tonnes by 2011-12. Therefore, it is envisaged that in the next five years, demand will grow at a considerably higher annual average rate of 10.2% as compared to around 7% growth achieved between 1991-92 and 2005-06.

[58] Press Release, Ministry of Steel, Government of India
[59] Joint plant Committee

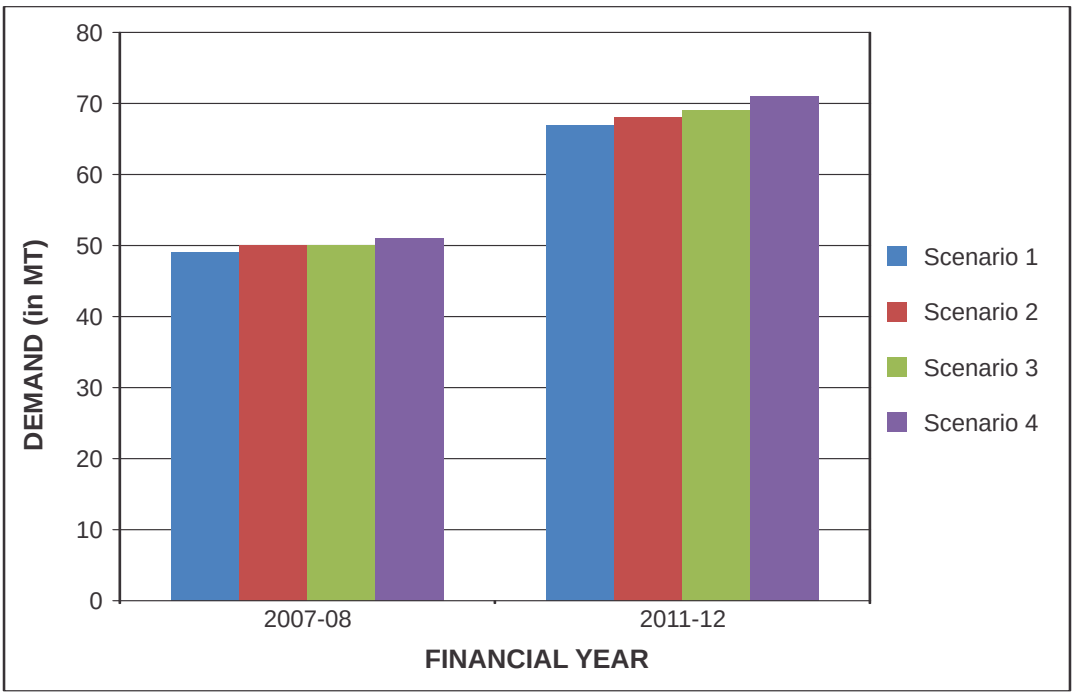


Fig. 12.2 : Growth in Steel Demand Under Different GDP Growth Scenarios

12.14 XII FYP and Beyond

While aiming for the second position in global steel production we should also ensure that steel production matches, indeed goes beyond, what the country demands under the XII FYP infrastructure development plans. Our iron ore is of good quality and has captured the export market, particularly China. However, we need to leverage our ore reserves as a means of generating employment, by enhancing steel production capacity, for accommodating the increasing entrants into the workforce, thanks to the demographic dividend the country will enjoy in the next two decades or so. In this sphere, the civil engineers will have to play a significant role.

State governments, Orissa in particular, have signed a number of MoUs for setting up steel plants of various capacities. To realize these MoUs on the ground, we need a workforce populated by engineers, a significant portion of civil engineers.

12.15 Manpower Requirement to Meet Future Demand

Today the steel industry has a total workforce of 5,00,000 and in order to achieve the target of steel production of 276 MT by 2019 - 2020, as per the National Steel Policy 2005, would require an additional workforce of 2,20,000 even after accounting for the expected productivity improvements. There are a number of employment opportunities like site engineer, packaging engineer, shift in charge, surveyor, geologist, contractor, supervisor and other posts in the steel industry.

Engineers constitute broadly 10% (≈22,000) while diploma holders and ITI pass outs come in at 15% each. The real challenge, however, lies in imparting new skills and capabilities to the workforce in tune with changes in technology and the emerging needs of globalisation. Going by the capacities that are being created to meet the rising demand for steel by 2020, the industry would require an additional 30,000 engineers in the next 10 years while the requirement of civil engineers, particularly during the setting up of the facilities, in this industry would be around 15%. This would translate into 4,500, civil engineers, comparable to the requirement of the cement industry.

Therefore, combining both steel and cement industry, the annual requirement of civil engineers would be in the range of 900.

CHAPTER 13

PHARMACEUTICAL INDUSTRY

13.1 Background

This document has so far focused on development of various infrastructure sectors to sustain the economy on the current growth path or achieve a higher one for assessing the Civil Engineering manpower required. However, Civil Engineering also plays a significant role in industrial development - in creating the necessary built-up space, addressing the resource and environmental requirements of various industries as well as logistics. This chapter assesses the requirements of civil engineers for the fast growing pharmaceutical sector. This industry is taken only as a sample and the number of civil engineers it requires for the projected growth is likely to be repeated to an equivalent extent by each of the other major industries, namely, textile, automobiles, chemical, petroleum, to name only a few. Hence, the estimate of manpower developed herein is necessarily a lower bound.

The Indian pharmaceutical industry is one of the world's largest and most developed, ranking fourth in volume and thirteenth in value globally. The domestic pharmaceutical market size was estimated at ₹. 43,300 crores in 2008. The country accounts for an estimated 8% of global production and 2% of the world market in pharmaceuticals. The industry has been growing rapidly in recent years. It has now an unprecedented opportunity for further expansion. Its longestablished position as a world leader in the production of high-quality generic medicines is set to reap significant new benefits as the patents on a number of blockbuster drugs are scheduled to expire over the next few years. In addition, its cherished position as a preferred manufacturing location for multinational drug manufacturers is quickly spreading into other areas of more value-added outsourcing activities such as R&D, and clinical trials, particularly for drugs for illnesses that afflict the Indian population, e.g. diabetes.

The Indian pharmaceutical industry registered strong growth during the IX and X FYP periods and has emerged as an area of strength especially in generics.

13.2 X FYP

Pharmaceutical industry in India witnessed a robust growth over the past few years moving on from a turnover of approx. ₹. 5000 crores in 1990 to more than ₹. 55,000 crores during 2005-06. Exports also rose significantly to more than ₹. 22,216 crores during 2005-06. Production, domestic sales, and exports rose rapidly during the X FYP period. During this period domestic sales grew generally at the rate of 11%–15% and exports at the rate of 20%–26%. Industry estimates were that domestic sales will grow at the rate of 16% and exports at the rate of 30%-35% during the XI FYP.

Table 13.1 : Indian Pharmaceutical Market Size1[60]

(₹. in crores)

	2002-03	2003-04	2004-05	2005-06	2006-07
Domestic market	30,365	32,575	34,128	39,989	45,367
Export	12,826	15,213	17,857	22,216	24,942
Import	2,865	2,956	3,139	4,515	5,867
Total market size	42,326	47,332	52,029	62,566	68,442

[60] Annual Report 2008-09, Department of Pharmaceuticals, Government of India

13.3 XI FYP

The turnover of the industry was ₹.78,610 crores during 2007–08, ₹. 89,335 crores during 2008-09, and ₹. 95,670 crores during 2009-10. Exports increased significantly to more than ₹. 24,942 crores in 2006–07.

India's rich human capital is its greatest asset for this knowledge-based industry. The industry projection is that by the end of the Plan period, domestic sales will increase to ₹. 78,000 crores and exports to ₹.1,12,000 crores. By some estimates, the global R&D expenditure on pharmaceuticals may touch USD 100 billion by 2011–12 of which India's share at the end of the current Plan could be in the range of USD 1–3 billion.

Total outlay of the Gross Budgetary Support (GBS) and Expenditure during this XI FYP (at current prices) is shown below:

Table 13.2 : Total outlay of the Gross Budgetary Support (GBS) and Expenditure [61]

(₹. in crores)

Dept. of Pharma	XIFYP GBS	2007-08 (actual)	2008-09 (actual)	2009-10 (actual)	2010-11 (BE)	GBS in first four years in XI FYP
	1,396.2	76.6	110.1	102.2	165.0	453.9

In order to improve infrastructure, a special scheme for setting up Pharma Parks in the country (separate for bulk and for formulations) in the next 5 years is needed. Initially 10 Pharma Parks with an investment of ₹. 25 crores each may be considered. The implementation of the scheme through a Special Purpose Vehicle (SPV) along with the involvement of industry associations needs to be worked out. This may be on the lines of the scheme for Textile Parks, another industry that will depend significantly (water, effluent treatment etc.) on Civil Engineering during the commissioning phase and moderate involvement in the O&M stage.

As per the Working Group the total requirement of funds during the XI FYP would be ₹. 3,560 crores out of which infrastructure development requires an estimated ₹.1,670 crores.

13.4 Looking Ahead - Civil Engineering Manpower Projections

The domestic market for pharmaceuticals has the potential to clock ₹. 54,720 crores in sales and ₹. 1,05,600 crores in exports by 2012. The near-term growth rates are expected to be about 13% to 14% for domestic sales and about 23% to 25% for exports.

Table 13.3 : Projected Industry size[62]

(in ₹. crores)

2008	2012	2018	2020
86,900	1,57,300	3,52,000	4,59,000

[61] Department of Pharmaceuticals, Mid-term Appraisal of the Eleventh Five year plan Report by the Planning Commission, GOI
[62] CSO, ASI, Annual Report- Department of Chemicals and Petrochemicals 2008-09, Ministry of Chemicals and Fertilizers, IPA, IMaCS Analysis

The projected human resource required in order to achieve the above mentioned growth is given at Table 13.4.

Table 13.4 : Projected Manpower Requirement[63]

2008	2012	2018	2022	Incremental
8,00,000	11,00,000	18,00,000	24,00,000	16,00,000

Assuming the Civil Engineering professional requirement at the onset of a project to be one percent(1%), an increment about of 13,000 by 2020 would be necessary i.e., an average annual enhancement of 1,100.

The Indian economy had, so to say, focused on the service sector over the past decade or so. This did not have a very helpful effect on employment generation. While it is not the case that the pendulum should swing back to manufacturing, as it goes without saying that growth in manufacturing needs to be accelerated. It is in this context, that we may confidently assert that the demand for civil engineers from the various industries will increase, as is evident from this one example, of the pharmaceutical industry.

[63] CSO, ASI, Annual Report- Department of Chemicals and Petrochemicals 2008-09, Ministry of Chemicals and Fertilizers, IPA, IMaCS Analysis

CHAPTER 14

ASSESSMENT OF AVAILABLE CIVIL ENGINEERING MANPOWER

14.1 Background

This document has so far reviewed the infrastructure development plans for remaining years of XI FYP, and the projections for XII FYP, given the opportunities for and constraints in mobilizing the resources.

While the monetary aspects of the projections are important, it is necessary to focus on the availability of the required workforce in sufficient numbers and of necessary quality. Over a Plan period, particularly one where the focus is on accelerated infrastructure development like the XI FYP, investment on the construction component may go as high as 50% of the total investment. The engineering profession, in particular, Civil Engineering, has an important role to play in ensuring fruitful utilization of these investments, including operation and maintenance of the created assets.

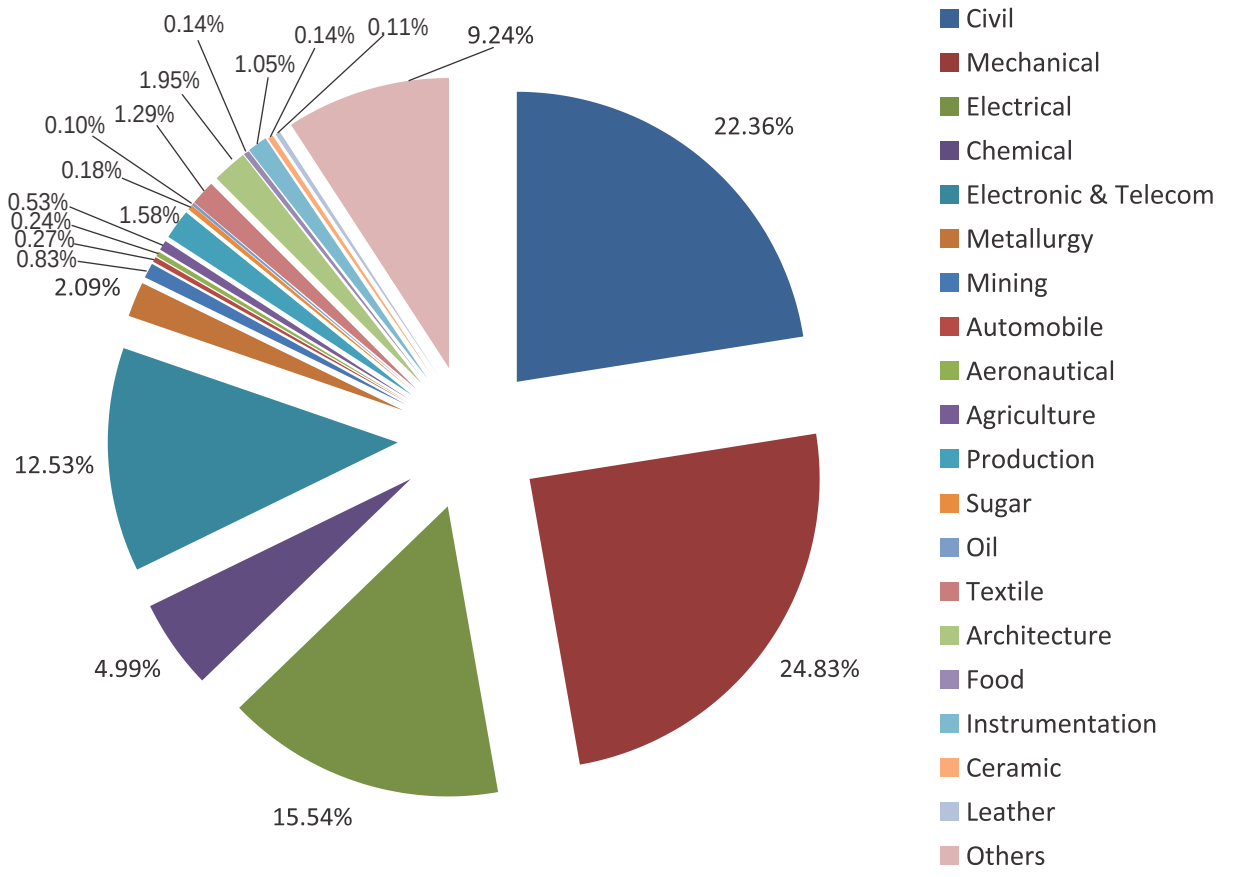


Fig. 14.1 : Engineering Degree Holders in the Working Age Group (as of 1996; source DST)

India finds herself in a fortuitous juncture right now. Massive infrastructure developments are on the anvil as well as India is projected to enjoy a rich demographic dividend over the next two decades. On infrastructure, GoI investment has risen from X FYP to XI FYP. The proposed investment for XII FYP is more than ₹. 46,12,500 crores (an increase from 8.37% to 10.7% GDP). This presupposes that resources including personnel needed for infrastructure development programme are available. However, translating such resources into highly trained and skilled ones is a challenge and concerted efforts are required to remove the hurdles. Hence, it is essential for the Government to provide for matching quality personnel in various spheres through appropriate education, HRD and S & T policies.

It is heartening to note the emphasis and priority accorded to the infrastructure development by the Planning Commission as a means to promote growth and inclusive development.

As mentioned earlier, infrastructure development in any sector requires significant Civil Engineering inputs. A pragmatic assessment of the lower bound number of the Civil Engineering graduates needed to realize the Plan, reviewed briefly in the previous chapters is truly mind boggling, particularly in the light of the perceived prospects of Civil Engineering as a profession over the past two to three decades.

It is reported that many educational institutions dropped Civil Engineering from the slate of programs offered. Moreover, between 2003 and 2008, there was hardly any proposal for setting up university departments for teaching Civil Engineering. However, things are changing for the better with emphasis on setting-up Civil Engineering departments / programs and other conventional courses in response to market dynamics and the perceived potential of the discipline, for all infrastructural sectors.

Even so, it is not an easy task to revamp a venerable profession which had been allowed to languish for about a decade and that too in a short span when demand is tending to double. The following sections would review the current situation regarding Civil Engineering education and assess the gap between the requirement and what might be available on "as is" basis.

14.2 Availability of Civil Engineers

Estimated stock and the actual out-turn of the number of Civil Engineering graduates and diploma holders from 1997 to 2003 as per the record from NTMIS, AICTE, Govt. of India is shown in Table 14.1.

Table 14.1 : Estimated Stock and Out-turn of Civil Engineering Graduates and Diploma Holders[64]

Estimated stock	1997	1998	1999	2000	2001	2002	2003
Degree	1,66,750	1,72,830	1,78,860	1,84,860	1,90,760	1,96,560	2,00,544
Diploma	3,28,490	3,38,690	3,48,150	3,58,460	3,68,660	3,78,760	3,86,238
Out-turn							
Degree	8,998	8,787	9,119	9,336	7,422	7,471	NA
Diploma	12,155	12,672	12,213	14,211	11,379	13,389	NA

Keeping in mind that the data given above refer at the latest to 2003 and there have been significant shifts in people's perception about Civil Engineering opportunities, it is seen that the average workforce enhancement nation-wide per year was no more than 5,000. Though the discipline has become more popular over the last couple of years, the estimated size of recent graduating class is not more than 15,000. Though there might have been a dip in the rate at which Civil Engineering graduates are migrating to other fields, particularly IT and management, the trend is still at a significant level.

However, such a trend is reversing now. Increasing demand in sectors like construction and real estate, power, and automobile is responsible for this change. New trends suggest equalization of remuneration at the starting level. It may be expected that with the focus on infrastructure the race to the top could accelerate even in Civil Engineering, making the discipline more attractive.

[64] NTMIS, AICTE, Govt. of India

As mentioned earlier demographics is playing in the country's favor. About 860 million persons would be in the age group of 15 to 59 by 2020, and this is a marked increase from about 725 million in 2010. The projected population and its demographic (refer to Fig. 14.2) suggest that 12 million persons are expected to join the workforce every year.

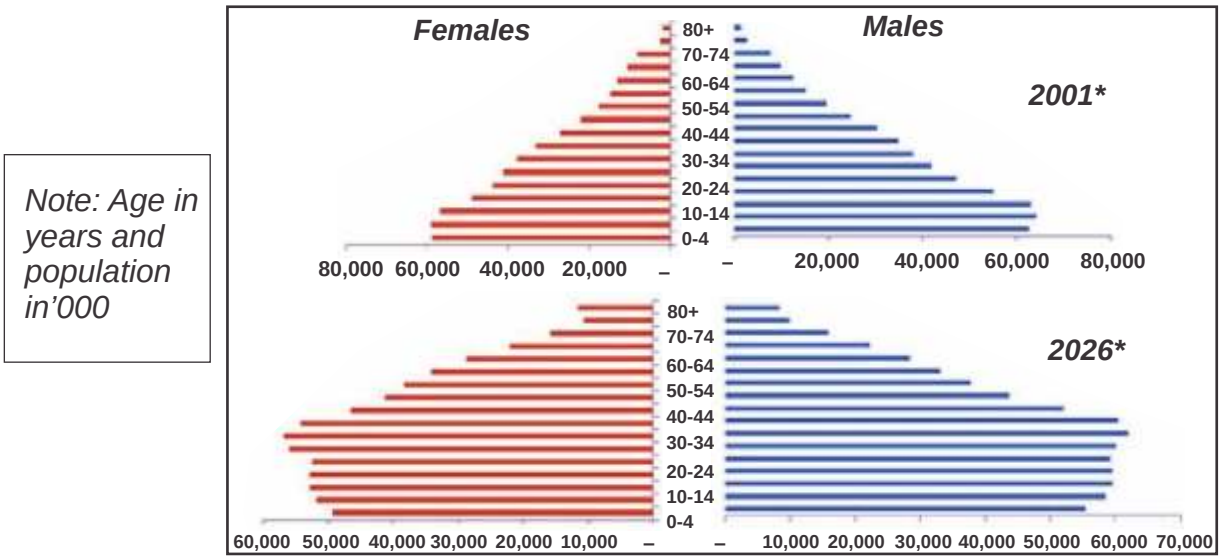


Fig. 14.2 : Projected Populations till 2022[65]

14.3 Civil Engineering Education – Degree and Diploma Courses

Institutions offering Civil Engineering education at the Bachelor's level in India can be broadly classified as under:

(i) Government of India funded institutions,

(ii) State Government/State funded institutions, and

(iii) Self-financed institutions, (while acknowledging that there indeed are hierarchies amongst each category).

More than 500 engineering colleges offer degrees in Civil Engineering, including among others, Indian Institute of Science, Bangalore (IISc), Indian Institutes of Technology (IITs), Institute of Technology-Banaras Hindu University (IT-BHU), National Institutes of Technology (NITs), Birla Institute of Technology & Science, Pilani (BITS) etc. The sanctioned intake of Civil Engineering students in the year 2001 was 13,806 and in the decade preceding that the CAGR was an anemic 0.2%. This rate might have increased since 2008, as mentioned earlier, but the impact would be seen after a lag of about six to seven years. This assessment is founded on the opinion expressed often by industry experts that graduating engineers are "not ready for the industry / not employable".

Table 14.2 presents the scenario for the year 2009-10. The numbers mentioned in the table are ball-park figures for most of the institutes and for the rest, the best estimates are considered.

[65] Census Projected Report and iMaCS Analysis

Table 14.2 : Educational Institutions awarding Civil Engg / Infrastructural Engg. Degrees / Diplomas (as of 2010)

		Out Turn		
	No. of Colleges	**UG/Diploma**	**PG//Doctoral**	**Faculty**
Govt. & Private (including NITs)	533	31,526	1,638	6192
IISc, IITs & BITS	9	542	1,144	377
Polytechnics	605	39,202	-	-
Total	**1,147**	**7,1270**	**2,782**	**6569**

When the demand for Civil Engineering professionals projected as per Plan outlays runs into tens of thousands per year, the current situation is disheartening and which requires immediate and concerted action.

There is often a chasm between the elite engineering colleges and the new ones, many of which are self-financed. It is not easy to satisfy the stringent conditions for accreditation in Civil Engineering, including provision of adequate laboratory space, equipment etc. Further, there are heavy expenses for acquiring proprietary software for road and highway design, structural analysis, water resources analysis, traffic and transport analysis, project management etc. Faculty requirements are often difficult to meet. In fact, the shortage of faculty was a grave concern when a number of new IIT's were proposed to be set up recently.

The recent large-scale expansion in engineering education has often come at the cost of the quality of educational offerings. Various factors, including, inter alia, the affiliating University system, outdated curricula, inadequate academic infrastructure, shortage of qualified teachers, poor teaching / learning processes, etc. and have all contributed in different degrees to this state of affairs.

It must be understood that any effort that may be taken to address this deficiency will have a time lag in showing improvement. The Indian higher education system is one of the largest higher education systems in the world. The sheer vastness of the higher education system can be gauged from the fact that in the past five decades there has been an impressive growth in the universities (from 25 to 367)[66], colleges (from 700 to 18,064)[66] and students, from 1 lakh to 112 1akhs[66].

The regional divide in educational and R&D institutions is a matter of concern. Over 60%[66] of these institutions are located in just about 6-8 States[66]. Improving access and equity in the North East and J&K is needed. The four States of Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu, have an intake capacity of over 3,00,0003 amounting to more than half of the national capacity. New colleges/universities must be set up in educationally backward districts to provide easier access to students. A specific plan for upgrading a few select universities with potential for excellence must be formulated.

A state-wise break-up of the engineering colleges offering Bachelor's degree in Civil Engineering (enrolment as of 2010) is given in Table 14.3 detailing the seats in undergraduate, post graduate classes in Civil Engineering and the corresponding faculty. Fig. 14.3 to Fig. 14.6 show corresponding distribution. The breakup and distribution do not include the Institutes of National Importance namely IISc, IITs, BITS and IT-BHU. The breakup and distribution of Institutes of National importance are presented in Fig. 14.7.

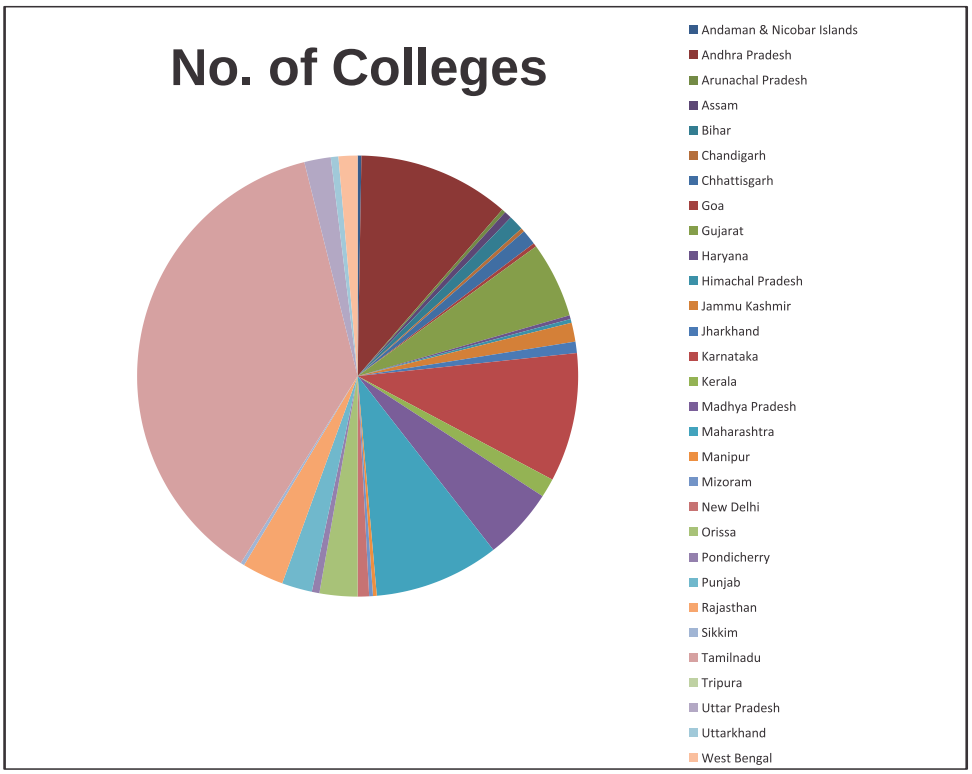
[66] Source: Report of The Steering Committee on Secondary, Higher & Technical Education, for XI Five Year Plan (2007-2012) Government of India Planning Commission, April 2009

Table 14.3 : Civil Engineering Colleges state-wise with approximate intake (enrolment as of 2010)

State	No. of Colleges	B.E/B.Tech	M.E/M.Tech Seats	Faculty
Andaman & Nicobar Islands	1	30	5**	10
Andhra Pradesh	60	3720	288	858
Arunachal Pradesh	1	60	10**	10
Assam	3	184	25	29
Bihar	6	310	10**	64
Chandigarh	2	120	75	25
Chhattisgarh	6	250	18	57
Goa	1	40	5**	10
Gujarat	30	1850	115	363
Haryana	1	65	15	48
Himachal Pradesh	2	60	10**	15
Jammu Kashmir	7	388	43	63
Jharkhand	4	300	12	29
Karnataka	50	3038	226	759
Kerala	8	618	18	161
Madhya Pradesh	28	1480	7	289
Maharashtra	49	3187	334	643
Manipur	2	50	5**	10
Mizoram	1	25	5**	5
New Delhi	4	130	30	36
Orissa	16	976	26	168
Pondicherry	2	75	10**	21
Punjab	12	600	60**	60
Rajasthan	17	600	50	104
Sikkim	1	60	10**	10
Tamilnadu	198	12110	62	2113
Tripura	1	40	5**	10
Uttar Pradesh	10	500	20	100
Uttarkhand	3	120	10	18
West Bengal	7	540	129	104
Total	**533**	**31526**	**1638**	**6192**

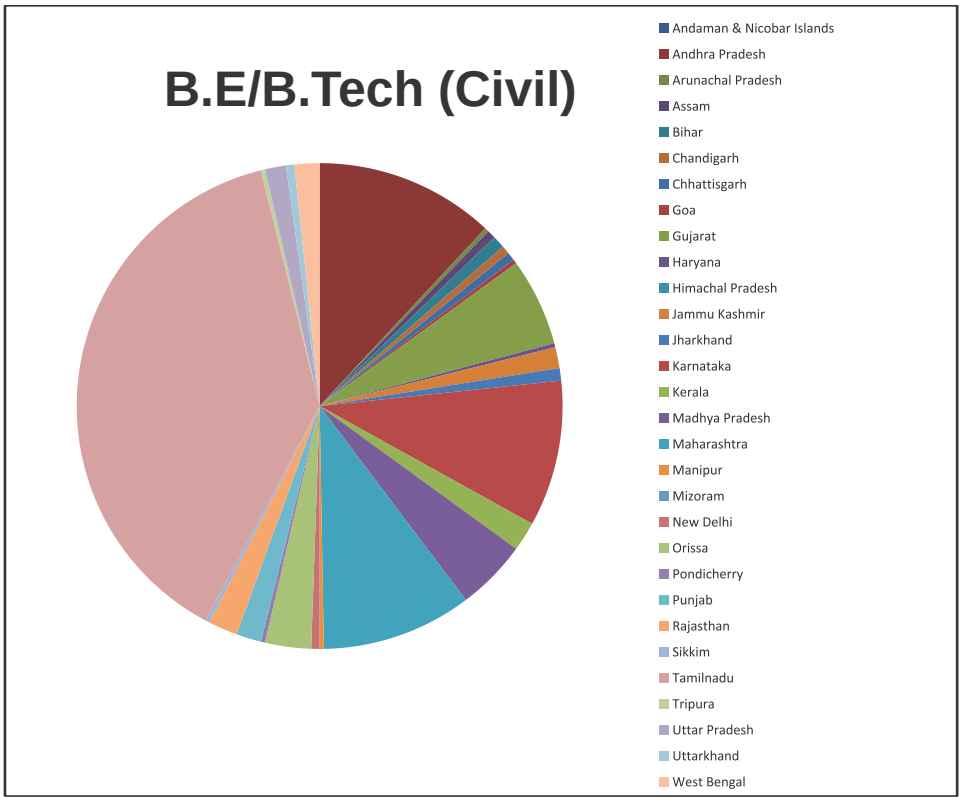
(includes NITs, excludes IISc, IITs, IT-BHU and BITS)

** Incomplete or no data available. These are notional numbers arrived at by regional and literacy rate considerations.



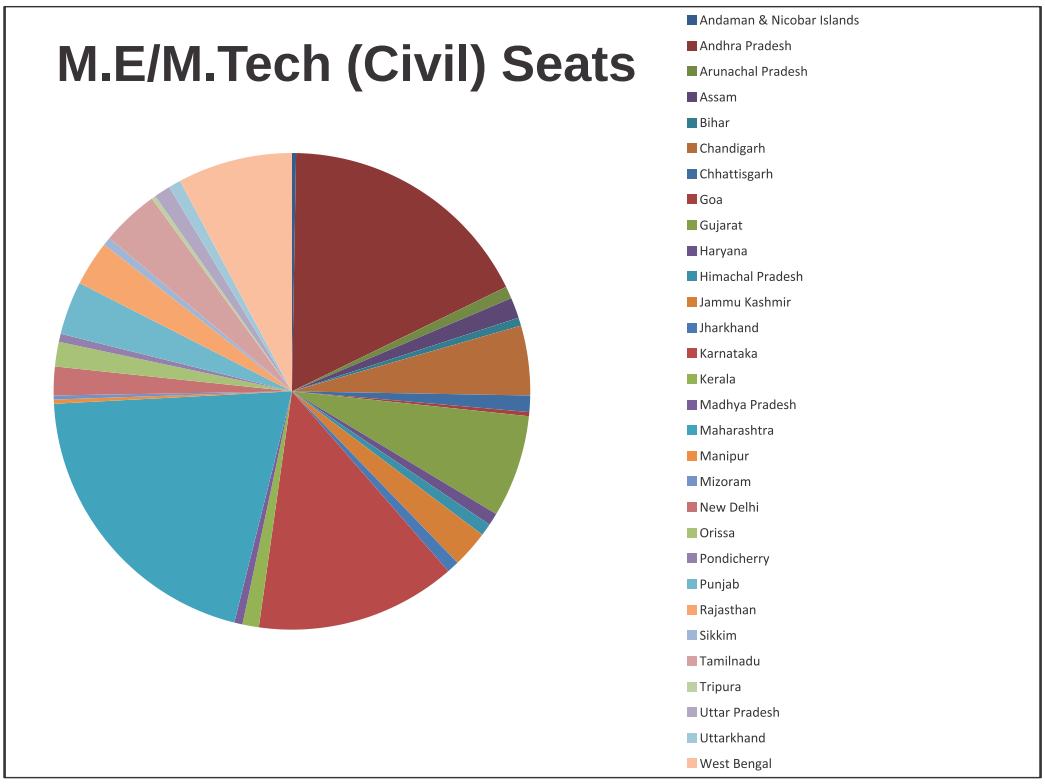
Note: Table 14.3 given as a Pie chart

Fig 14.3 : State-wise breakup of Colleges Offering Civil Engineering colleges including NITs



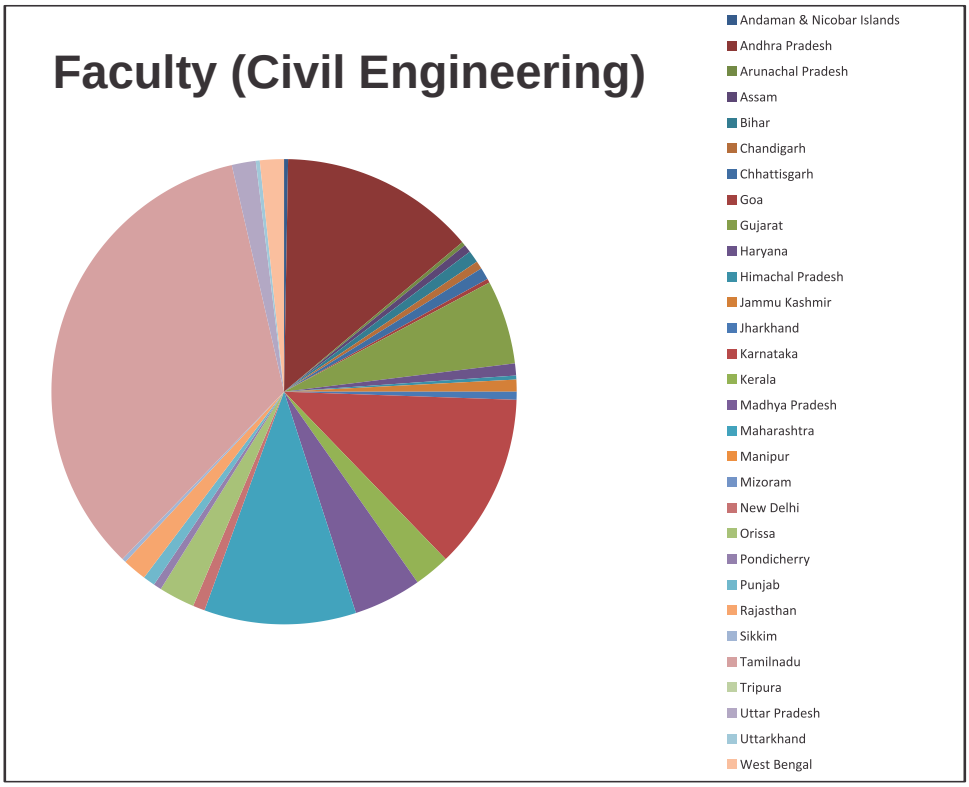
Note: Table 14.3 given as a Pie chart

Fig 14.4 : State-wise breakup of B.E/ B.Tech Seats in Civil Engineering colleges including NITs



Note: Table 14.3 given as a Pie chart

Fig 14.5 : State-wise breakup of M.E/M.Tech Seats in Civil Engineering colleges including NITs



Note: Table 14.3 given as a Pie chart

Fig 14.6 : State-wise breakup of Faculty in Civil Engineering colleges including NITs

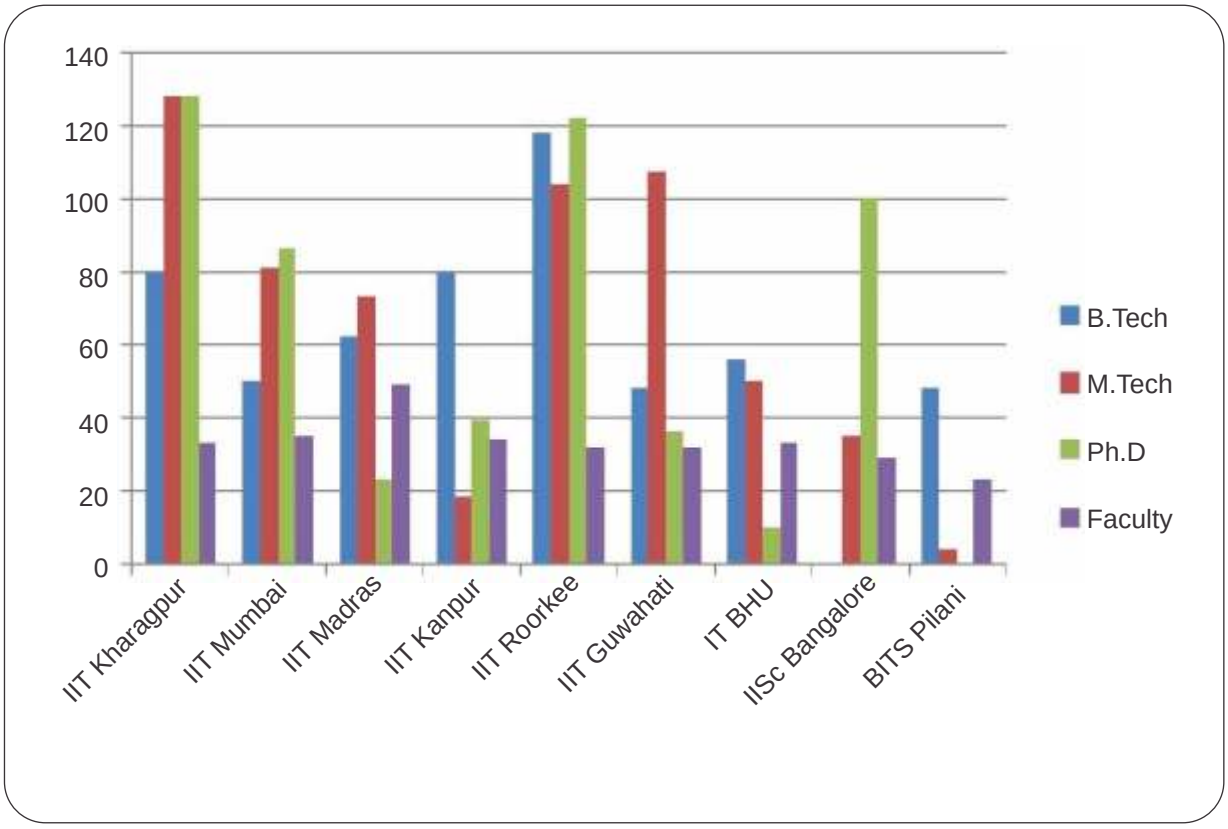


Fig 14.7 : Data with respect to Institutes of National Importance

As per the details (as of 2008-09) available in public domain (mainly from www.indiaedu.com,) the number of polytechnics (diploma colleges) offering Civil Engineering courses are around 600. A state-wise break up approximate of such colleges is given in Table 14.4 along with the intake (number of seats). This shows that, on an average, approximately 39,000 diploma holders in Civil Engineering are produced every year. Figs. 14.8(a) and 14.8(b) show the state-wise distribution of polytechnics and seats in Civil Engineering. Data regarding faculty were difficult to obtain.

Table 14.4 : Polytechnics (Dip in Civil Engg) state-wise with approximate intake (enrolment as of 2010)

State	No. of Colleges	Seats
Andaman & Nicobar	1	30
Andhra Pradesh	49	2100
Arunachal Pradesh	1	30
Assam	7	480
Bihar	8	450
Chandigarh	1	40
Chhattisgarh	4	120
Goa	3	120
Gujarat	29	1720
Haryana	4	225
Himachal Pradesh	3	90
Jammu Kashmir	9	420
Jharkhand	4	250
Karnataka	84	3623
Kerala	27	1365
Madhya Pradesh	19	680
Maharashtra	14	806
Manipur	1	60
Mizoram	1	60
Nagaland	1	60
New Delhi	3	180
Orissa	18	835
Punjab	5	260
Rajasthan	5	123
Tamilnadu	243	22600
Tripura	2	60
Uttarpradesh	35	1055
Uttarkhand	1	30
West Bengal	23	1330
Total	**605**	**39202**

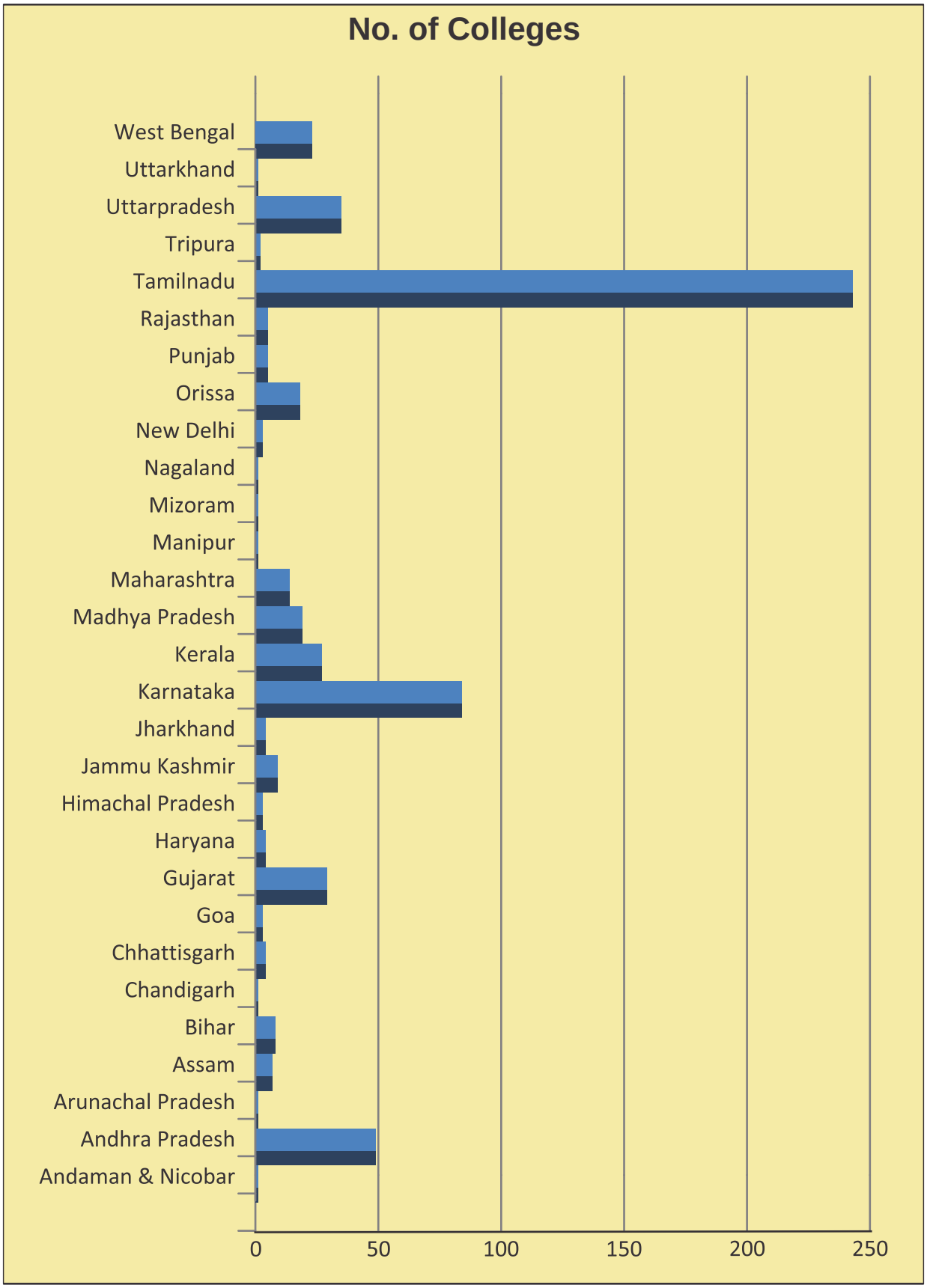


Fig. 14.8(a) : Number of Polytechnics as on 2010 State-wise Offering Civil Engineering programs

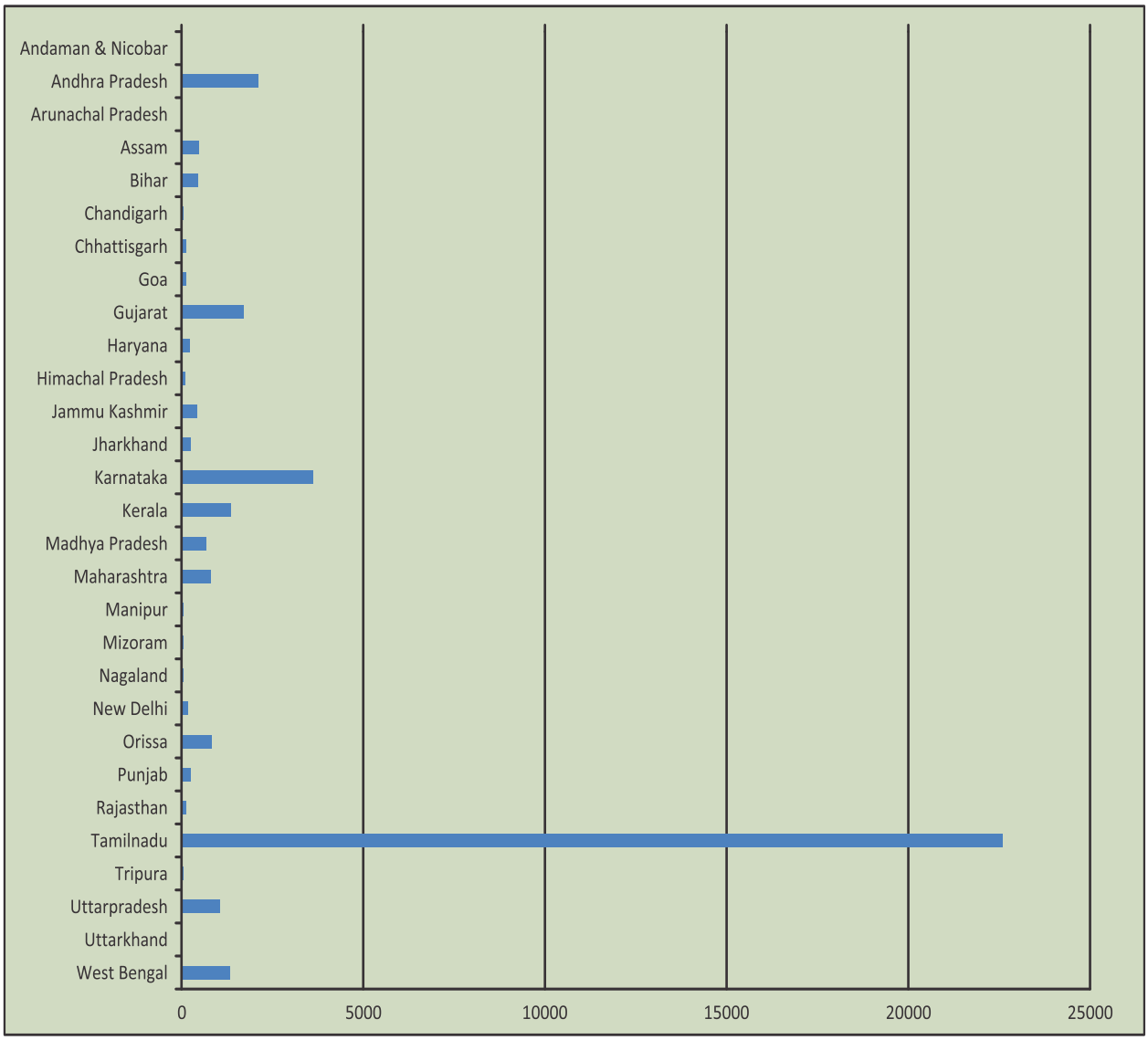


Fig. 14.8(b) : Approximate Civil Engineering Intake (no of seats) for 2010-11 in the Polytechnics

However, considering that (a) Candidates sometimes fail to complete / fulfill the requirements of degree, diploma, etc. for various reasons and (b) Candidates take up / pursue other professions where the Civil Engineering degree / diploma / certificate etc. is not required, the numbers projected earlier would have to be reduced by 30-35% and vary anywhere between 65% to 70% at least, if not less. This would project / estimate the number of Civil Engineers available as:

- estimated graduate in 2013-14 to 22,000
- estimated graduate in 2010-11 to 15,500
- estimated diploma holders in 2012-13 to 25,000
- estimated diploma holders in 2010-11 to 17,700

Polytechnic education is to create a pool of skill based manpower to support shop floor and field operations as a middle level link between technicians and engineers. Such trained personnel from diploma level institutions in engineering play an important role in managing shop-floor field operations. The ratio of degree to diploma holders is currently around 2:1, whereas ideally it should be 1:3. This may be because of more private participation in the engineering degree sector compared to the diploma sector. There is also a societal perception that degrees command a premium in the job market over diplomas.

Over the years, the diploma programs have deteriorated losing the skill components, and have resulted in became a diluted version of degree education. The organizations employing such people have to train them all over again in basic skills. Some of the major problems faced by the polytechnic education system areas under:

• No focus on new and emerging areas

• Inadequate infrastructure facilities/ obsolete equipment

• Lack of quality teachers

• Financial constraints

• Inadequate opportunities for training/ retraining of faculty and staff

• Lack of autonomy to the institutions

• Inadequate industry/ institute interaction

• Lack of R&D in technician education

• Curricula not updated.

Indeed, this is relevant for the graduate level education system also.

In order to impart right and appropriate Civil Engineering education that would address the three chief concerns relating to i) what should be taught, ii) who would be recruited and absorbed and iii) what will be the engineering practice, it is imperative that we have to look for out-of-the box solution. One cannot delink education and employment any more.

14.4 Steps Taken for Enhancing Supply and Skill Development

Various steps are being taken towards training the new entrants of civil engineers as well as portion of the existing workforce, such as formulation of the National Skills Development policy, delivery of Modular Employable schemes, upgrading of existing institutions through World Bank and Govt. of India funding, as well as upgrading training institutes under PP mode, setting up of the National Skill Development Corporation, and the plan to establish 50,000 skill development centres. Apart from these, several ministries / department and state governments are engaged in skill development initiatives.

Given the significance of skill development as well as the quantum of funding involved, there is also the overarching need for quality structures to be in place, especially from the perspective of successful implementation. Such quality standards and processes are required at all segments of the “skill development value chain”. This has to be complemented by linking funding to outcomes as well as incentivizing good performance.

Implementing agencies are likely to face challenges right from mobilizing trainees, developing standardized and scalable content, ensuring the availability of trainers, making available appropriate infrastructure, and coordinating placement and industry linkages.

The GoI has approved setting up of 1,000 new polytechnics - 300 polytechnics under public sector for educationally backward districts, another 300 through Public Private Partnership (PPP) mode and the remaining 400 as private ones.

XI FYP provides an amount of ₹. 910 crores for strengthening 200 state level technical institutions. The target is to train 3.5 lakh apprentices under the Scheme of Apprenticeship Training. From 2007 to 2009, 1.13 lakh apprentices were trained.

A nation-wide scheme of Sub-mission on Polytechnics has been launched. Under this scheme new polytechnics will be set up in every district that does not have one already, ensuring deep penetration of such skills. These Polytechnics will be established with central funding and over 700 will be set up through PPP and private funding.

The National Skill Development Corporation (NSDC) was set up in 2008 with a seed capital of ₹. 1,000 crore in an effort to bridge the gap between demand and supply of skilled personnel across various sectors. To start with, it had a modest goal of contributing about 30 per cent to the overall target of imparting skills to about 500 million people in India by 2022. The Government set up a three tier structure for co-ordinated action on skill development. – The Prime Minister's National Council on Skill Development, The National Skill Development Coordination Board and the National Skill Development Corporation India. As many as 28 states and five Union territories have setup Skill Development Missions and are now mapping the skill gaps in major sectors and formulating action plans to bridge them. NSDC has committed ₹. 667 crores to support private and government-aided skill initiatives and has approved to 26 projects to date. NSDC's Project partners – Construction &Real Estate Developers Association of India intends to train 97,920 over 12 years in 12 centres at a projected cost of ₹.18.53 crore.

Such programmes, though not directly related to the main thrust of this research effort, can substantially help the realization of the ambitious infrastructure plans in various sectors. The skill development programme, administered under the Craftsman Training Scheme (CTS) is operated by Industrial Training Institutes (ITIs) and Industrial Training Centres (ITCs). Training is provided in 32 engineering and 22 non-engineering trades approved by the National Council for Training in Vocational Trades to people in the age group 15 to 25 years. There are 7,500 it is / ITCs with an overall capacity of 75,000 across the country. The training is provided in small duration trades such as Carpentry, Electrician, Plumber, Auto-technician, Painters, Packages, Multipurpose Technicians, Masons, Dairy Assistants, etc. The duration of the training program varies from 1-2 years or small duration of 2–3 months. The resource persons for the program are drawn from rural engineering departments of state governments, faculty of engineering colleges / polytechnics / ITIs and others. The trainees may also be provided one or two week's orientation program in relevant industries.

It is necessary to integrate such training programs in collaboration with and funding support from Ministry, Departments of the Government of India viz., Science & Technology / Industries / Rural Development / Labour as well as of the State Governments and Industrial Associations.

The XI FYP also envisaged that intake of technical education institutions grows at 15 per cent annually, to meet the skilled human resource needs of the growing economy. Outlay under the XI FYP for Technical Education is ₹. 26,300 crores and the allocation for the first four years ₹. 15,053 crores. The anticipated expenditure for the first three years has been ₹. 7,829 crores.

As on 30 June, 2009 there were 7,272 technical institutions including management institutions with an intake of 14.10 lakhs for degree and 2,324 diploma level institutions with a total enrolment of 5.08 lakh students, thereby making an aggregate intake of 19.18 lakh students. Thus, the total technical education enrolment at 19.18.lakh accounts for only 9.48 per cent of total higher education enrolments. This is not adequate for a country of continental size. Another dimension is the skewed distribution of the existing technical institutions. While the States of Bihar, Uttar Pradesh and West Bengal have a deficit of engineering colleges, Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra have large concentration of private institutions. The Government has expanded the students' intake both through creation of new institutions as well as by augmenting the intake by 54 per cent to provide OBC reservation. The number of AICTE approved technical institutions which was 5,269 at the beginning of the XI FYP, has increased to 9,596 as on June 2009. These comprise 2,872 engineering and technology colleges, 1,659 polytechnics.

AICTE has permitted second shifts in certain engineering colleges and polytechnics to augment the intake capacity. National Board of Accreditation (NBA) has revised the criteria for accreditation of institutes to bring them at par with international parameters. Another area of concern is the skewed distribution of intake in the system. Most of the enrolments at present are in few branches of engineering and the intake in some core branches has been shrinking. This imbalance is likely to create underutilization in the institutions and cause acute shortage in specific fields such as Civil Engineering, which will hamper the accelerated growth of real estate and construction sector that makes a robust contribution to the GDP. AICTE has taken some measures to overcome the imbalances. Besides permitting second shifts in engineering and polytechnic institutions in select areas, it is now mandatory for new institutions to have the minimum conventional three branches of engineering. The impact of these measures needs to be assessed. The intake of students at undergraduate level in existing seven IITs at Delhi, Mumbai, Kanpur, Kharagpur, Chennai, Guwahati and Roorkee has increased from 4,977 in 2008-09 to 5,464 in 2009-10. The Government has approved setting up of eight new IITs in the States of Andhra Pradesh, Bihar, Rajasthan, Orissa, Punjab, Gujarat, Madhya Pradesh and Himachal Pradesh. All the eight new IITs have started functioning. In addition to the existing 20 National Institutes of Technology (NITs) with an annual intake capacity of about 15,000 in engineering and related subjects, ten more NITs have been approved under the XI FYP and is proposed to set up in Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Goa (which will also cater to Union Territories of Daman and Diu, Dadra and Nagar Haveli and Lakshadweep), Puducherry (which will also cater to Andaman and Nicobar islands) Sikkim, Delhi, (which will also cater to Chandigarh) and Uttarakhand. The concerned State and Union Territories are in the process of identifying suitable land for the institutions.

The two new Schools of Planning and Architecture (SPAs) have been set up at Bhopal in Madhya Pradesh and Vijayawada in Andhra Pradesh. The new SPAs have started functioning from academic session 2008-09 from temporary premises.

It must also be underscored at this point that the efficacy of engineering education is closely linked with the educational back-up from school level and is inter-twined with the Higher Education Scenario (See Annex - 14/1)

Annex 14/1

Assessment of Available Civil Engineering Manpower

Higher Education Scenario

It is estimated that a total of 70,000[66] (50 % for girls) fresh scholarship at the graduation level and 15,000 scholarship at PG level will be awarded during first year and after it is operated for a period of 5 years, the number of scholarship which scheme being awarded every year would reach to 4,20,000[66] in the fifth year.

Only 5%[67] of the Indian labor force in the age group of 20-24 has received vocational training whereas the percentage in industrialized countries is much higher, varying between 60% and 80%. The illiterate and the literate up to the primary level of education constitute a very high proportion of the existing work force, and the two together accounts for nearly 67% of the work force. While on the one hand the level of educational attainment of the existing work force is very low; on the other, the educated without professional skills constitute 69%[67] of the total unemployed people. Over 200 million students enroll for schools in Class I each year, but only 20 million of these are able to finish Class XII i.e. 90 % of the school students drop out at different stages.

The Common Minimum Programme of the Government has laid down the goal of 6% of GDP for the education sector as a whole by the end of the XI FYP. The Committee on Reaching National Common Minimum Programme's Commitment of 6% of GDP to Education, under the Chairmanship of Late Prof. Tapas Majumdar, outlined various scenarios under which this goal could be reached, and has set a target of 1% of GDP for higher education. Compared to this, the current expenditure is only about 0.4%. The Approach Paper to the XI FYP had proposed raising this expenditure by about 0.25% or to about 0.65% but this suggested increase is not based on rigorous quantitative targets and estimates. A projection of the growth rate of enrolment (GER) in the 1991 and 2001 Census provides an estimate of total enrolment in higher education of ₹. 2.07 crores or a GER of 15.6%. With the proposed XI FYP target, the total enrolment is estimated to increase to ₹. 2.97 crores (increase of ₹. 90.7 lakhs) and the GER to 20.6 per cent in the terminal year of the XI FYP. The share of technical and professional education is expected to change from 25 to 30%[68] over the XI FYP period in the formal sector alone. As a percentage of GDP, the total outlay on higher education is expected to increase from 0.95% to 1.14 %[68].

[67] Report of The Working Group on Skill Development and Vocational Training, set up for preparation of Eleventh Five Year Plan (2007-2012) Government Of India Planning Commission, 2006

[68] Draft Report of Working Group on Higher Education 11th Five Year Plan, Government of India, Planning Commission, New Delhi

Table 14/1-1 : Estimate of Enrolment (Enrolment in 000)[69]

Year	Academic Year	Population Age 18-23	Total Higher Education	Total GER	Addl. Total Enrol-ment	Share of Technical Edu. in Total Enrol. (%)	Total Tech & Prof Edu.	Share of Pvt. Enrol. in Tech & Prof.	Total Gen	Share of Pvt. enrolment in Total Education	Pvt. Enrolment In Gen. Education	Publicly funded General Education	Addl. Publicly funded General Enrolment
	Base Year												
2006	2006-07	132243	13934	10.5		0.25	3535	0.2	10399	0.08	408	9991	
	11th Plan												
2007	2007-08	135440	15034	11.1	1100	0.26	3909	0.22	11125	0.084	403	10722	731
2008	2008-09	138318	16460	11.9	1426	0.27	4444	0.24	12016	0.088	382	11634	912
2009	2009-10	141257	18222	12.9	1762	0.28	5102	0.26	13120	0.092	350	12770	1136
2010	2010-11	144259	20341	14.1	2118	0.29	5899	0.28	14442	0.096	301	14141	1371
2011	2011-12	144287	22365	15.5	2024	0.30	6709	0.3	15655	0.1	224	15432	1291

Table 14/1-2 : Enrolment by Levels and Major Disciplines

Year	Ph.D	PG	General Graduate (Art, Science & Commerce)	Technical Graduate (Engg., Medical, B Ed)	Total Higher Education (Degree (2+3+4+5)	Diploma	Total Higher Education (Degree, Diploma) (6+7)
1	2	3	4	5	6	7	8
1980-81	25417	291341	1886428	239267	2442453	430126	2872579
1990-91	32468	354216	3285776	416828	4089288	796686	4885974
2000-01	45004	647338	7244915	688625	8625882	987279	9613161
2001-02	53119	647016	7139497	790050	8629682	1104594	9734276
2002-03	65357	782590	7633125	1035701	9516773	1199785	10716558
2003-04	65525	806636	8026147	1110840	10009148	1191447	11200595

Table 14/1-3 : Number of teachers in Institutions of Higher Education, 2004-05[70]

Institution	Enrolment (in '000)	Teachers (in '000s)	Student teacher ratio
University Departments & University Colleges	13,88	77	18
Affiliated Colleges	90,93	3,95	23
Total	**104,81**	**4,72**	**22**

Referring to Table 14/1-2, the number of PhDs from Indian Universities should increase fivefold within a span of ten years with proper standards 68.

Encouragement needs to be given to interdisciplinary movement between science & technology streams and industrial R&D by establishing 20 engineering schools that admit students with a bachelor's degree in sciences for a two-year B.Tech. Degree in selected areas requiring strong science-technology interface 68.

The XI FYP envisaged large scale expansion in university education by setting up 1455 new educational institutions comprising 30 Central universities, 8 IITs, 8 IIMs, 10 NITs, 20 IIITs, 3 IISERs, 2 SPAs, 374 Model colleges and 1,000 polytechnics.

A provision of ₹. 84,943 crore has been made for the Department of Higher Education (DoHE) in the XI FYP representing a massive increase over X FYP outlay of ₹. 9,500 crores. The allocation for the DoHE during the first four years of the Plan is ₹. 34,683 crores and anticipated expenditure during the first three years is placed at Rs. 17,753.49 crores. Out of the total allocation of ₹. 9,600 crores of the DoHE for the Annual Plan 2009-10, UGC has been provided a grant of ₹. 4,375crores and the actual expenditure (fund certified) as on 31 March, 2010 was ₹. 3,589.85 crores, that is, 82 %.

[70] UGC Annual Report, 2004-05

Priorities for Civil Engineering Education

The INAE publication entitled, "Profile of Engineering Education in India – Status, concerns and Recommendations" is a very comprehensive work of great value which lucidly addresses the past and present concerns and future steps for action.

The following paragraphs take a closer look at a few of the issues involved in trying to upgrade the quality of engineering education in general, which are equally applicable to Civil Engineering.

Fostering Creativity

The importance of encouraging and nurturing the creative instincts that exist in everybody and particularly in those who aspire to the heights of Civil Engineering has been underestimated. The ability to seek a creative solution, to synthesize, to be imaginative, is a property that should be cultivated. Sadly, traditional engineering courses do not encourage creativity.

Design engineering requires skills that need fostering just as much, or more, than the analytical skills of engineering science and it is important that design is a key part of the curriculum. One needs to give much greater attention to what one teaches, how it is organized, how successful it is, how effectively it nurtures basic (but probably repressed) creative skills, what proportion of the curriculum should be given to synthesizing rather than to analyzing, and how individual progress can be measured. Academics like to measure things. If something cannot be given a quantitative mark, it becomes questionable. One needs to reconsider that attitude and change it. If engineers don't address design issues, particularly in Civil Engineering design, then onus shifts to the architects.

Student internships in industry provide a great opportunity. As well as providing splendid professional experience they also offer the opportunity for service in a meaningful way and allow responsibility to be taken early in a young person's career. One needs to have in an educational institution a full-time officer responsible for undergraduate placements in industry. Limited practical experience is required before a student may graduate.

Engineering for Transformation

The curriculum must allow for change. Change to itself and change to the technology it embraces. Much has already been said and written about the never ceasing development of technology, and particularly the rapid rate of development of information technology in recent years. Graduates in Civil Engineering have a particular responsibility to be aware of the bigger and holistic picture because they are the ones who will have to deal with it. Governments face a major challenge to balance the benefits of industrial and economic development, which are driven by the consumption of energy, with the impact of that development on the environment and infrastructural facilities.

Our students must be educated to address an environmental agenda and to approach technology in a holistic way. Because they can understand and assess the issues and they will then have a unique responsibility to contribute to these debates. Civil engineers must work on the world stage. They must be prepared to address the ethical and moral issues of their work as much as the purely technological.

Role of Educators

One must provide educational programs which recognize the world agenda. Inter-disciplinary teaching, not just across the engineering front, but with colleagues in other disciplines, is the only way of properly addressing these great issues.

That does not mean abandoning the hard science which is the bedrock of a sound basis in engineering principles. It means supplementing this with a broader spectrum of material to cover a wider canvas. Helped by the development of distance and web-based learning technologies which provide new teaching tools and new opportunities, students can do more than sit passively in classrooms and in front of computer screens. Education remains a social as well as a cognitive experience. The notion that teachers are providers and students consumers of education seems to miss the essential point.

The word education stems from its Latin root educere, to lead out. And that is the main task for educators - the function is to lead. Good students can teach themselves almost anything. Good teachers lead by providing the framework and motivation for their students' learning. And it is to encourage and advise during the learning process, to provide by example the incentives and role models for students, and to demonstrate the opportunities and responsibilities of professional engineers, that is the function of a teacher. The tradition that the teacher leads and the student follows can only work if there is the time and the opportunity for faculty and students to work together in small group teaching so that each may influence and guide the other.

Mentoring Approach

The tradition of small group teaching is a long one. Long before there was any thought of engineering as a profession, indeed before the word engineer had been coined, the apprenticeship principle had become established. It was not possible to practice a craft or trade without having served an apprenticeship first. Student and teacher worked together for several years before the student was judged fit to work unsupervised. Although this custom has largely died out in the engineering profession, the same traditions still linger in other profession. Lawyers, accountants and doctors are all apprenticed to fully-qualified professionals before they can themselves practice and receive full accreditation. We call this as “mentoring approach”. And, in the ancient and many other universities, every student has a personal tutor and one or more supervisors charged with overseeing their academic progress.

The provision of personal tuition as an integral part of university courses is expensive and is vulnerable whenever cost-saving studies are made. Government funds still contribute a large proportion of the costs of university education, tuition fees are under attack.

This encourages the move to larger classes and reduces staff involvement wherever savings can be made. In different ways, and for different reasons, there is the same pressure to cut costs in whatever country a university works.

Role of IT-Based Technologies

Educational material is increasingly offered over the internet. Some major universities have linked up with major information and entertainment providers in the private sector. These partnerships will be attacking the global market in higher education. Universities provide most of the academic expertise and the "branding"; commercial partners provide the production, distribution and marketing facilities. And many major corporations are using the distance learning and on-line model of education for their own management and business training. Their objective is to develop a learning culture by providing job-relevant training within their organizations.

There is an essential difference between the provision of training and the provision of education. There is scope to incorporate the human element into web-based teaching. The essential element of a university is that teachers and students work together. The very name university means a corporation of teachers and scholars working together. The mentoring or tutorial approach lies at its heart. Whether that element of human interaction is possible in an e-university remains to be proven. One knows how immediate e-mail communication, blogs, Wikipedia, etc. are and how rapidly a friendly exchange can be begun between

persons who have never met. The difficult task for educators is to work out how the tutorial approach can be adapted to long-distance learning.

Collaborative Learning

Collaborative learning can be provided at the following four levels:

• Common courses

• Student exchanges

• Integrated research

• Professional practice and entrepreneurship.

We anticipate that there will be benefits to both sides on many different fronts, but, above all, this collaboration will provide the opportunity and the incentive to broaden our faculty interests and connections and to introduce a truly international dimension into our teaching and our academic affairs.

The key objectives are to remove the obstacles of time and place that separate us; to deliver more cost-effective learning opportunities; and to develop new approaches to learning and assessment. As custodians of part of the knowledge base, we have a responsibility to share this knowledge and the opportunities that go with it. Sharing a design curriculum on-line is a particular challenge. Developing and releasing creative talent and ensuring that this receives a proper allocation of time and encouragement is another. Multi-disciplinary teaching across the broad canvas of world technological need is a very important third objective. The ability to use modern telecommunication links to interact over long distances provides an opportunity that we have yet to grasp.

As our students mature and address the great issues that face humanity as this century unfolds: poverty, food, disease, housing, education, environment, energy, we have to make education available not just to our own constituencies but to the wider world. A world network of affiliated universities may be the solution. Getting on-line is the easy part. Our challenge is to provide ways of offering academic leadership to individual students, wherever they may be. We have to work out how to do that.

Students as well as teachers have a part to play. Undergraduate programs may include an internship semester with the opportunity for practical work. Graduate courses can encourage professional activities when these are relevant to educational objectives. Students no longer need to be out of day-to-day contact with their course supervisors while carrying out this work. And while extending their own horizons, they may also contribute directly to the local society in which they find themselves. Many medical courses have provision for clinical training when young doctors are encouraged to spend a semester working in unfamiliar surroundings alongside an experienced doctor. This is a feature of medical education which deserves to be more widely adopted.

CHAPTER 15

GAP ANALYSIS & FINANCIAL IMPLICATIONS

15.1 Introduction

Infrastructure development has rightly emerged as the cornerstone for the nation's growth strategy for sustained and inclusive development. This was highlighted by the Prime Minister, Dr. Manmohan Singh, recently, in the context of finalizing the approach paper for the XII FYP.

The demographic dividend, to be leveraged at the earliest, imposes a sense of urgency on such efforts. While rapid urbanization makes education more accessible, it requires, at the same time, significant improvements in the quality of our technical education. Both these important aspects have to be reconciled through a robust, pragmatic program, keeping in view our financial resources.

This Report has until now tried to quantify the human resource requirements for various infrastructure and a few industrial sectors. Therefore, the estimates of human resource requirement are necessarily lower bound numbers. It has also delved into the significant aspects of Civil Engineering education in India, including into the quantity and quality of engineers graduating from our educational institutions, the geographical spread of educational facilities, the accessibility of these facilities to the various segments of the population, vocational training aspects, the financial resources directed to the sector, their adequacy, and a few other matters.

Even a cursory look at the details emerging out of the above efforts shows a wide gap between what is required and what the existing Civil Engineering educational infrastructure can produce. It is this chasm that needs to be bridged. Obviously, for the simple reason that an unheard sum of ₹. 46,12,500 crores is sought to be absorbed by infrastructure within a short span of 5 years starting from 2012, during the XII FYP, the sense of urgency is sharpened. Further, the demographic dividend that India is poised to reap also shows up within this time frame, perhaps extended by a decade or so. Therefore, any and all efforts have to be severely frontloaded.

In this chapter the gap between the human resources required and its implications for the financial resources required to meet such demands are dealt with. The possible sources and mechanisms of funding are touched upon.

15.2 Sectoral Disaggregation of Manpower Demand

It would be recalled that the estimated human resource requirements for various infrastructure sectors during the XII FYP are, briefly, as under:

- For the Roads and Highways sector, an extremely Civil Engineering intensive one, the annual additional requirement of civil engineers is estimated at 38,400. The railways, aviation, ports and IWT sectors, would require 5,400, 105 and 21,000 civil engineers annually, respectively. Hence, transport infrastructure alone would need about 65,000 civil engineers annually

- The Irrigation sector would require 28,000 additional graduate level civil engineers per year

- Energy and power, one of the mainstays of industrialization and economic growth demands the services of civil engineers to the extent of additional 26,000 annually

- Rapid urbanization will lead to unmitigated inflationary expansion for services like water supply / sewage / waste disposal / drainage and environmental protection, together with other needs that would require about 36,000 civil engineers per annum

- The other sectors reviewed in this Report – telecom, real estate, cement and steel, pharmaceuticals– would require a total of 7,800 civil engineers annually

Hence, the lower bound of the requirement of civil engineers would appear to be about 160,000. Tables 15/1-1 and 15/1-2, given at Annex 15/1 present in a capsule form the assessments arrived at in Chapters 3 to 13, dealing with various sectors. Table 15/1-1 gives the indicative / assumed investment levels for each year of the XII FYP period. Table 15/1-2 translates the human resource requirements as estimated in the same chapters. Together they make clear the level of human resource enhancement we are looking at if we want the investment plans for XII FYP to be realized.

The *demand* number needs to be considered in the context of the upper bound of about 16,000 Civil Engineering graduates, of excellent / good / average capability entering the profession annually across the nation – the supply number, estimated for the year 2012-13. It must be noted here that reliable numbers of addition to Civil Engineering graduate workforce indicate only about 14,000 in 2008 at an optimistic CAGR of 2.5%. That is, the Business-as-Usual (BAU) approach, even at first look, is assessed as grossly inadequate, if we are serious about our plans for XII FYP. The situation is equally bad at the level of vocational training.

It is in this context Table 15/1-3 has been developed. The average gap between demand and supply over the XII FYP comes out at about 140,000 Civil Engineering graduates. However, we must remember that the table has been time-shifted towards the present from the future, as the first batch of students from the enhanced facilities will not be entering the workforce before 2016, if we assume that the plans for enhancement are started right this minute. This is an important caveat to be remembered.

15.3 Engineering Education and Professional Training

The evident need for enhancing engineering capabilities has to be met both quantitatively and qualitatively. Professional training for engineers involves two distinct aspects:

• Formal engineering education programs

• In-Service training of graduate engineers.

In this scenario, the requirement of funds and also their sources for these two distinct features have to be reviewed for getting a comprehensive picture.

To start with, we identify two distinct sources of funds for Civil Engineering development. Instead of the usual first-stop at the national budget, particularly the apportionment for higher education, we examine how funds from project allocations could be leveraged.

However, such an exercise has to be carried out taking into account relevant elements which are viz., the pool of in-service engineers available for in-service training without adversely affecting project completion schedules, and without diluting the quality of the deliverables, the absorption capacity of our technical education infrastructure for the funds allocated to formal Civil Engineering education, the number and quality of teaching staff available etc. It is emphasized that this exercise is indicative in nature and deals with orders-of-magnitude estimates only.

15.4 Funding from Projects

One begins by reviewing possible mechanisms for directing a portion of the project financial resources for enhancing the pool and the skills/capabilities of the Civil Engineering workforce.

Some preliminary calculations indicate that as much as 35% of infrastructure investment in the last year of the XI FYP and the tenure of the XII FYP will go into Civil Engineering. This amount may be reckoned at ₹. 23,02,621 crores a part of which may be utilized in a focused and coordinated way for skill up gradation.

The table below helps in putting the matter in an appropriate perspective, and shows details of the projected annual allocations during 2012-2017 for the Civil Engineering component of the sectors considered.

Table 15.1 : Year-wise Allocations During XII FYP (Estimates) for Civil Engineering Intensive Projects

Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Allocation (₹. Crores)	2,28,346	2,65,383	3,25,985	4,08,126	4,95,652	5,79,129

A small draw down on these allocations through an innovative mechanism is discussed in the subsequent section.

15.5 Fund Requirement

An assessment shows that about 1,60,000 students need to enter the Civil Engineering profession for the next few years, at the very least, till the end of the XII FYP. As the current output of civil engineers from the engineering educational institutions is of the order of 14,000 per year, there is a huge gap of about 1,45,000 per year. Evidently, this cannot be closed at one go. However, resolute steps need to be taken towards the objective, even if they be only incremental.

The details as under may be taken in an order-of-magnitude sense. Setting up a new 4-year degree programme with a class strength of 60 with adherence to the AICTE norms on relevant aspects, including, inter alia, lecture halls / class rooms, laboratory facilities, faculty at the stipulated faculty-student ratio and other miscellaneous items, would require a one-time capital expense of ₹ 4 crores and a recurring annual expenditure of about ₹. 1.5 crores.

Tuition fees, at the rate of about ₹ 60,000 per year for 240 students would fetch an annual revenue of about ₹. 1.5 crore. Hence, the outgo on account of Civil Engineering education is almost exclusively for establishing a programme for class strength of 60.

Hence, an enhancement of Civil Engineering seats by 1,45,000 would cost less than ₹. 9,700 crore. It must be understood that this is a one-off cost, with the recurring expenditure paying for itself through tuition fees.

Apart from producing fresh professionals, it is accepted the world over that technology is changing at a furious pace. Experts of yesterday might bite the dust tomorrow. Continuous professional development through intensive training in emerging fields has become the sine qua non of good education and funds have to be allocated for the same.

In 2003, (the latest year for which numbers are available), the total number of graduate Civil Engineering professionals in the workforce across the country was about 2,00,000, and the annual increment was in the range of only 5,000, at about 2.5%. Assuming that the growth rate has risen perhaps to 3% over the past five years, with a number of colleges opening up and the technical education scenario attracting education entrepreneurs, one may arrive at a tentative overall figure of 250,000 graduate civil engineers.

Such a level of professional Civil Engineering cadre would make it impossible to allocate a significant proportion of them for in-service training on a formal basis. Hence a pragmatic way out has to be found.

Targeting about 25,000 in-house engineers for a three month training course per year at a cost of ₹. 100,000 each, the total outlay required for the year 2011-12 would be ₹. 250 crores.

Now, for 2011-12, the total cost would be the sum of the capital cost of establishing formal Civil Engineering graduate programmes to boost the graduate output to a total of 160,000 and the training of 25,000 in-service personnel would be about ₹. 10,000 crores, to give brief details ₹. 9,700 crore + ₹. 250 crores = ₹. 10,000 crores. For the year 2011-12 this amounts to 4.4 % of the project cost.

One must keep in mind that the one-off amount in establishing the institutions could be covered to some extent by the enhanced budgetary allocation to technical education, which stands at 0.65% of the GDP. The amount to be taken from the project cost may be fixed at 1% for the first year (2011-12) of this multi-year initiative and at 0.5% for the subsequent years as per requirements.

An appropriate framework for this approach is put forth in the next section.

15.6 Education Budget

Government allocates about 3.75% of the GDP to Education. This is grossly insufficient, particularly when the economy is shifting more towards the tertiary sector requiring higher capabilities from the workforce. Nations like South Korea spend about 6% of their GDP on education. The need for suitable increase has found all round acceptances. It is however impractical to expect such a steep increase in one step – and absorbing that increased allocation would also not be possible. Hence budget allocations should indicate a steady progress. This appears to be the case in the Budget for 2011-2012.

The Budget includes the following items for the education sector

• Allocations for UGC have increased from ₹. 3,626 crores to ₹. 4,556 crores, an increase of about 26%

• Funding for eight new IITs was increased by 100%, from ₹. 250 crores to ₹. 500 crores

• Seven new IIMs were allocated ₹. 60 crores, an increase from ₹. 25 crores

The distribution of the funds allocated has to take note of the crash programme of infrastructure development and the increasing technology intensiveness of the economy. This appears to be the rationale for setting the target for higher education at 1% of GDP whereas it was an anemic 0.4% at the start of the X FYP and 0.65% suggested during XI FYP.

15.7 Education Budget – Civil Engineering Apportionment

Accelerated infrastructure development has a sharp focus on Civil Engineering. As is well known, for increasing the share of engineering fields like civil, mechanical, electrical engineering vis-à-vis fields like electronics, computers (particularly software) and other courses imposes steep demands on laboratory space and equipment which are capital intensive. In Civil Engineering particularly the requirements of field workers increase the additional burden of an enhanced employment force down the hierarchy levels e.g. diploma holders / supervisory staff / and other semi-skilled labor.

In 2010 India registered a GDP of ₹. 67,00,000 crores. Assuming that 0.65% of GDP had been directed (as envisaged) to higher education comprising general graduates, engineering, medical and B.Ed, the amount would come to about ₹. 43,550 crores. The allocation for the capital expenditure for establishing new degree Civil Engineering courses should come out of this amount.

15.8 Mechanisms for Project Funding for Education and Training

To sum up, it is proposed that all infrastructure project contracts crossing a predetermined threshold must have a line item for professional training of in-service engineers. From the second year onwards, after having established the educational infrastructure, providing for current expenditure from tuition fees, funding from project cost would be exclusively for in-service training. The industry, it may be presumed, would not be averse to such a contribution and indeed, the contribution could be appropriately varied as per requirements. Also, as the workforce increases in numbers and the graduates' capabilities are enhanced, it may well be that the training requirements would be more skewed towards emerging technologies, responding to climate change concerns, disaster mitigation, project management and other such businessfriendly efforts.

The project funding of education and training may be taken as a line item within the project cost. What is attractive about the above proposition is that the projects that are currently being executed are required to make a sustainable contribution to the future capability of the workforce. Of course, matters regarding establishing the required regulatory procedures / institutions / monitoring / ensuring equity etc. have to be carefully thought about and settled.

15.9 Other Factors

Apart from the financial aspects of developing an appropriate human resource programme to meet the requirements, other aspects need urgent consideration. This would include, among others, availability of faculty and researchers / incentives to commercial organizations to contribute to the growth through academic involvement / developing the required physical infrastructure /enhancing and intensifying the academia-industry interaction and other issues.

Annex 15/1

Table 15/1-1 : Investment (Data taken from the chapters on individual sectors)

in ₹. Crores

	2012-13	2013-14	2014-15	2015-16	2016-17
Roads	80,000	100,800	130,030	161,240	192,130
Railways	78,000	95,000	120,000	153,000	190,000
Airport	7,800	8,800	10,500	12,200	13,600
Ports+	13,200	21,000	34,800	49,500	61,500
Irrigation	66,000	82,000	109,000	132,000	151,000
Energy & Power	185,500	231,000	288,000	355,000	412,500
Env. Engg.	29,000	35,000	44,000	54,000	63,000
Telecom	6,570	7,900	8,750	9,410	10,300
Housing & Real Estate	46,500	53,200	58,700	62,700	68,200
Constn. Materials	93,400	105,800	118,100	125,700	137,300
Pharma	31,700	35,500	37,600	39,800	42,250
Total	**637,670**	**776,000**	**959,480**	**1,154,550**	**1,341,780**

Table 15/1-2 : Incremental requirement of Manpower

	2012-13	2013-14	2014-15	2015-16	2016-17
Roads	16,000	33,000	47,000	49,000	47,000
Railways	3,000	4,000	5,000	7,000	8,000
Airport	56	81	141	138	110
Ports	5,000	17,000	29,000	31,000	24,000
Irrigation	9,000	25,000	42,000	35,000	28,000
Energy & Power	13,000	24,000	30,000	35,000	29,000
Env. Engg.	12,000	30,000	45,000	49,000	43,000
Telecom	275	310	335	350	360
Housing & Real Estate	1,000	1,100	1,300	1,100	1,000
Constn. Materials	835	860	875	900	915
Pharma	700	800	1,200	1,300	1,500
TOTAL	**60,866**	**136,151**	**201,851**	**209,788**	**182,885**

Table 15/1-3 : Gap Analysis

	2012-13	2013-14	2014-15	2015-16	2016-17
Demand	60,866	136,151	201,851	209,788	182,885
Graduating CE	15,840	16,230	16,640	17,060	17,480
Gap	45,026	119,921	185,211	192,728	165,404

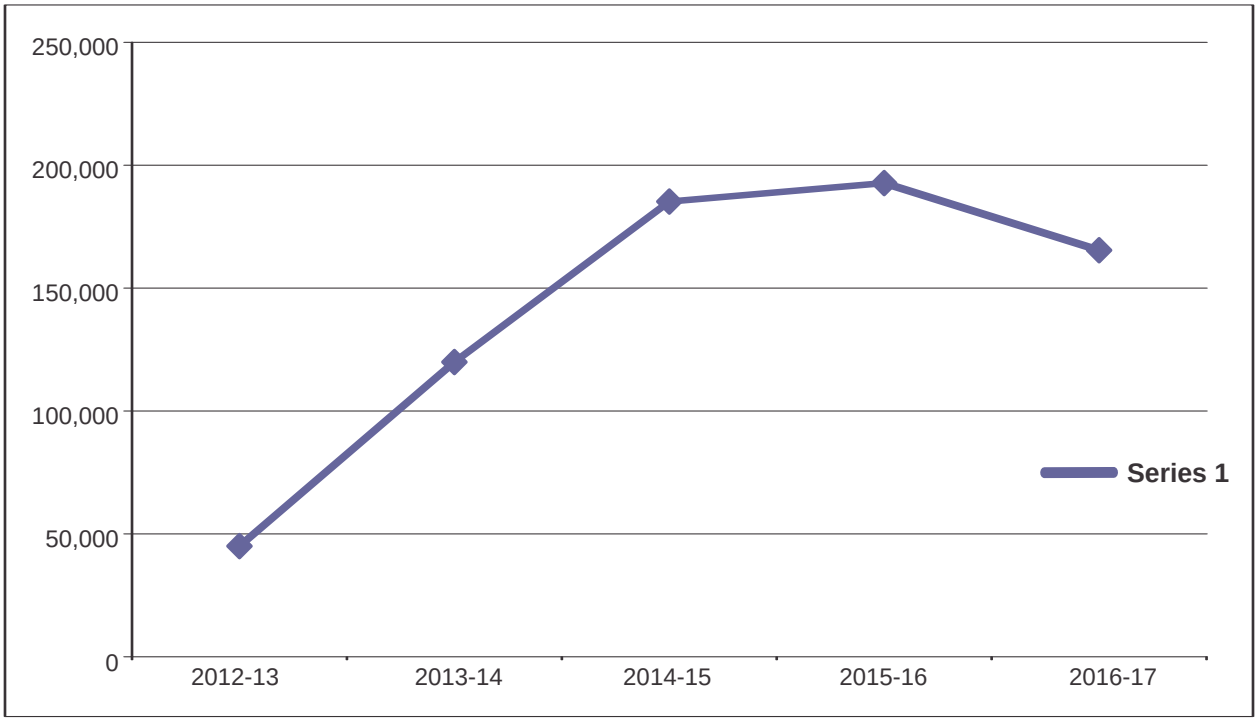


Fig. 15/1-1 : Gap Analysis

CHAPTER 16

RECOMMENDATIONS

16.1 Introduction

Enhancing the Civil Engineering capabilities of the nation in an appropriate manner is imperative for an efficient and effective infrastructure. This is a multi-faceted task which can be achieved only through meticulous planning and time bound action. This research paper seeks to indicate the contour of the process for change, for attaining the above goal.

16.2 Making the profession attractive to Senior Level School Children

In recent decades, the profession of Civil Engineering has not held much attraction for high school/college students. It is necessary to understand the genesis of this before considering remedial solutions. Attractiveness of any profession depends on various aspects, which are touched upon below.

One significant aspect is the new recruit's perception about the profession he or she is entering. An individual has to feel that in being involved in a particular profession he is fulfilling an innate desire to contribute his mite to society. Civil Engineering offers this in plenty. Every multistoreyed building, every long span bridge, every major hydroelectric project, every mega power plant and the like are examples of Civil Engineering. An intricate water supply system for the million plus citizens of an urban area comes through the efforts of civil engineers; the metro rail has a major component of Civil Engineering and so do thermal, hydro, solar, nuclear power stations. What about setting up industrial plants, planning and developing new urban areas? But all this is undermined by the tag of "brick-and-mortar" engineering. It is often said that technology is not what it was 50 years ago; it is "a lot more technology, a lot more competencies." This is true of Civil Engineering as a whole. Civil engineers, are, in no way, less than professionals of any other branch of engineering, and use the tools of IT and other new emerging technologies to an equal extent, if not more.

Further, Civil Engineering, no less than any other engineering field, offers myriad avenues of career advancement by remaining innovative. Hence, enhancing the effectiveness /efficiency of planning, design, execution, operation and maintenance processes through nurturing and implementing innovations, would offer greater opportunities for career growth within the profession.

Another important aspect is the remuneration package in the profession. Civil engineers typically start with a relatively lower package, though recent trends show a welcome change. There is also an impression that career advancements in Civil Engineering are not as fast as in some other sectors. This impression may be attributed to large scale migration of Civil Engineering graduates to IT/Management fields. However, this scenario is changing fast and the new entrants have to be apprised of the correct perspective.

The message of Civil Engineering not just being a "brick and mortar" engineering, and of having a bright future, has to be taken to high schools by doyens of industry, R&D institutions and academia. It must be pointed out, in a visually arresting manner, that civil engineers are proud of their accomplishments and indeed of their contributions to society.

The engineering profession, in particular Civil Engineering, does not attract many girl students. The profession cannot afford to pass up 50% of the potential human resource pool. Women in the Civil Engineering profession must be motivated to interact more often with the civil society and promote the profession actively amongst the girls. As a collateral advantage, it might even attract more boys to enter the profession!

16.3 Training for in-service engineers

A large number of practicing civil engineers in the country need to be acquainted with the latest tools and techniques. Many engineering institutions offer continuing education modules for industry professionals. The requirements for continuing education and skill up-gradation in the industry have to be identified by industry leaders, as well as professional bodies in consultation with the academic institutes. Flexible continuing education modules drawn up in consultation with industry representations would be more useful and facilitate more academia-industry interactions.

Professional training /skill development of in-service engineers, to keep abreast of the current technological revolutions is a huge challenge. Institutions such as the National Institute for Training of Highway Engineers (NITHE), National Inland Navigation Institute (NINI) at Patna, and others are playing a useful role in this field. However, their reach, size and mandate need to be extended, enlarged and widened to leverage the existing human resources.

While the steps outlined earlier mainly help the engineers in government organizations, the inservice professionals in the private sector, whose involvement is on a steeply upward curve, may be served by providing incentives to private entities by including training costs in project contracts as a line item.

Suggestions have been made that every private entity must have a training policy in its mandate. This would promote the idea that money spent on training is an investment and not expenditure. To begin with, it is suggested that a minimum of 1.5% of the salary budget of the organization may be allocated for training– this could gradually be increased to 5% of the salary budget.

Further the industry might be compensated via the tax route for any expenditure that it might incur for the training. These suggestions need to be evaluated in greater detail. The industry might also, over a period of time, create positions for specialist engineers in specific areas viz., Structural Engineers, Wind / Earthquake Engineers, Geotechnical Engineers, Transportation Engineers, Environmental Engineers, Bridge Engineers, Water resource Engineers and like for better utilization of knowledge/skills in the profession.

16.4 Improving Civil Engineering Education

The earlier trend of a dead end for Civil Engineering entrants seems to have ended and the trend is changing now, though faculty members to fill up the new opening positions are difficult to locate. Also, to maintain the current interest in Civil Engineering the curricula must be made more dynamic and updated / oriented better towards the emerging developments. Whereas, the following paragraphs cover a number of relevant issues, Annex 14/2 elaborates lucidly, several areas of concern, which need to be addressed with sensitivity to reshape the future of Engineering Education. This is already happening elsewhere in the world, but India with the enormity of its problems, has to tread with care.

It is necessary to have a periodic review of all Institutions – including among others, NITs and IITs. The details of the mechanism / process of review need to be discussed with the major stakeholders, namely, the Faculty / Industry / Government / students and the alumni. Seamless education through cross-fertilization of the knowledge and skills from related sectors should be the objective. Reform has to be oriented towards imbuing the engineers with relevant skill sets from other engineering disciplines as well from fields like management / communication etc. at appropriate levels.

Industry has to play a key role in improving engineering education in the country as also indicated in the foregoing paragraph. The industry should be consulted in defining key research areas and potential research issues. Similarly, the Academia must be responsive to Industry's future manpower and special training needs. While Civil Engineering education is not intended to equip students for specific jobs, the basic skill set and analytical capabilities required for most of the engineering jobs should be provided.

Further, during a course, a paid internship of four months with an industrial unit should be made mandatory to take full advantage of Civil Engineering education.

Civil Engineering industries need high level educational qualifications to develop and maintain an active innovation portfolio. Towards this end, scholarships for those in the service of the industry should be made more attractive for M.Tech and Ph.D. programmes. Larger number as well as enhancement of scholarship amounts for women candidates would help in tempering the current severe skew in Civil Engineering.

While working out the details it may also be considered whether a short sabbatical, of say 2 months (1/2 semester), may be offered to working engineers to lead the practical initiatives of the academic programmes.

Faculty shortage is another significant issue to be addressed. One of the options would be to encourage the practicing engineers as well as engineer consultants to teach Civil Engineering courses. Quality faculty generation, prescribing minimum educational qualification for teachers in engineering colleges and diploma institutions, motivational measures to enhance quality, induction of engineers from industry in to the faculty, mentorship programs, continuing education for faculty improvement, performance related salary / perks etc. are some of the other options that need to be looked into.

A number of issues have to be evaluated and resolved through interaction/communication between the academia / industry / government, through enabling provisions:

• Enhancing the basic platform currently available

• Consultation between the academia and the industry for a dynamic curriculum – revision / update on a continuing basis

• Industry – academia interaction at the highest level – workshops/Seminars at periodic intervals

• Focus on recent developments – probabilistic assessments, risk analysis, “Green” engineering, up-to-date IT tools

• Quick start and sustained progress on establishing and continually enhancing educational institutions

• No compromise on quality

• Making faculty positions attractive

• Faculty development, including continuing short-term courses for the members, introduction of the sabbatical system etc

• Professional training of (at least) 12.5% (one semester out of eight) during academic training –as a compulsory element to be evaluated with academic rigor

• Inviting guest faculty from industries offering focused case studies.

While it is true that infrastructure is being upgraded, the pace at which this is being accomplished leads to a widening gap between supply and demand. The demand increases mainly on the following counts: (i) population increase; (ii) ever faster urbanization; (iii) increasing lifestyle demands given the economic growth of the country.

The Report has squarely identified the inadequacy of the engineering education, in terms of both numbers and quality of graduating civil engineers, at the root of the current near-stagnant conditions. As other

factors such as institutional weaknesses, resource constraints etc. are beyond the remit of this Report, these have not been looked into. However, for a holistic solution, these also need to be given due consideration.

16.5 Improving Civil Engineering Research Inputs

There has not been sufficient attention given towards deriving benefits of research inputs from Civil Engineering in infrastructure development. The benefits of research come in the long term but the investment in it must be made in the early stages considering this view point. The technology must be upgraded as a result of research related to newer eco - friendly materials, technology for safe and cost effective solutions, testing and maintenance techniques, green technology, inputs from information technology, risk management, disaster resistant technology and probabilistic modeling etc. The initiatives and incentives to research engineers are to be considered in policy making. At present, very few engineers choose research as a profession. The research institutes need to be strengthened in terms of manpower and financial inputs; and there has to be close coordination with educational institutions and industry. Many educational institutions are also doing research in Civil Engineering. The research areas in research institutes and educational institutions must flow from the industry. Such a development is necessary for all-round development of Civil Engineering profession.

16.6 Action Plan

1. Establishing a large number of engineering education institutions, suitably distributed across the various regions of the country, and promoting Civil Engineering within them.

2. There are a number of engineering colleges that do not have a Civil Engineering department. In the interest of a balanced growth in the capabilities of the national engineering workforce, the bias against Civil Engineering in these colleges will have to be removed. Civil Engineering degree courses should be mandated for engineering colleges that seek approval.

- Establishment of institutions should ensure that the campus is a living, self-sustained entity. This alone would promote engineering education in states and regions that are lacking such facilities to the extent required, by attracting faculty and also students to the new establishments.

- The focus may be shifted away from the IIT model and towards the Tier 2 and Tier 3 levels, with a view to prepare engineers for immediate contribution to the profession.

- At 60 students per programme per year, the total cost for establishing a new department in existing institutions or new ones has been worked out as ₹. 9,700 crores to meet the expected demand. This is a one-off cost, and additional requirements may be only on account of new developments in the profession which should be foreseen and planned for proactively.

- If the existing Civil Engineering programmes are permitted to increase their intake capacity by 60, the cost will come down. The advantage would be faster action.

- Science graduates (particularly B.Sc with Physics), may be brought into the engineering stream through specially prepared programmes in existing institutions offering Civil Engineering education. The duration of such courses may be fixed at 2 years with 6 months job experience in industry.

- Requirement of Ph.D. Degree for faculty positions may be relaxed for undergraduate teaching, particularly as a short-term measure, in order to annul the acute shortage of faculty to whatever extent possible. A program of mentoring the teachers should be taken up as a formal requirement as an immediate measure.

- The academia will have to shoulder greater responsibility for shaping a graduate engineer for professional practice in a competent manner. A student must undergo mandatory professional summer training in industry for a duration of four months (2 months each following the 4th and the 6th semester) before the degree would be conferred on him.

- A programme of incentives to enter the engineering profession for rural population and girl students may be thought of to avail with the maximum advantages of the demographic dividend.

  The nodal agency for the above recommendations may be the Ministry of Human Resource Development, GoI, and state level authorities with appropriate responsibilities. For promotion of engineering education in rural areas, the Ministry of Rural Development, both at the central and state levels, should also be consulted to enhance local relevance by accommodating the requirements of proximate conditions.

3. A commensurate increase in diploma education needs to be planned. It is noted that there is a significant skew in the distribution of polytechnics among the various regions of the country. Polytechnics, typically, have localized catchment areas and the skills required, are more localized than graduate level competencies.

- The way forward would be to ensure a level playing field of diploma level educational facilities across the nation and any outgo on this count must come from state level mechanisms.

  The nodal agency will be the state level authority for technical education.

- Specialized training institutions, called Institutions of Civil Engineering Training (ICET), such as National Institute for Training of Highway Engineers (NITHE) should be established across the country, preferably 4 in number, to serve the 4 regions of the country with faculties mainly from the industry.

  Institutes that have local relevance like the National Inland Navigation Institute (NINI) at Patna will also have to be replicated across the country. The National Power Development Institute has been put on a strong footing through a combination of government and private party participation. The infrastructure like buildings, laboratory equipment, IT infrastructure have been assigned to the government whereas the industry offers its expertise by providing faculty. This model is eminently suitable in this instance, adopted across the nation.

4. The funds for enhancing the Civil Engineering education scenario and also for in-service training facilities must come from the project costs to the extent it can bear without endangering the viability of the project, particularly in the case of the PPP mode of execution. An indicative suggestion would be to include a line item at 1% of the project cost for the year 2011-12 and at 0.5% thereafter for the subsequent years for all projects.

   The nodal agencies for this initiative, which will be spread across the various sectors of infrastructure, will be the executing agency of that sector; for example, NHAI for roads and highways.

5. Setting up and managing such a fund for in-service training deserves serious consideration. It is suggested that a Civil Engineering professional entity may be established under the combined auspices of the Industry and the Academia for managing such a fund. This fund will feed the ICETs.

The proposed institutes (ICETs) will primarily cover the function of mentoring of faculty and of in-service training of graduates, apart from keeping track of the dynamics of the changing needs of the profession and the related curricular changes, by:

- Giving Input for academic programmes – curriculum upgrade, faculty training
- Facilitating industry-academia interaction, particularly with respect to the proposed mandatory professional training for award of a degree.
- Planning and design of training programmes, and ensuring their implementation
- Arranging knowledge dissemination events (as distinct from networking events) on specific topics e.g. disaster mitigation / climate change etc. that will have an impact on Civil Engineering practice in an inclusive manner.
- Promoting comprehensive development of the Civil Engineering profession – new technologies, new materials, new design developments etc.

Another important task that ICETs should undertake it to popularize Civil Engineering. What is proposed here is a sort of an outreach programme by the profession into the heart of the high schools in the nation, in urban as well as in rural areas. The proposed Civil Engineering professional bodies (ICETs) along with other industry associations like CII, FICCI and ASSOCHAM may be called in to develop a sustained and intensive programme in this regard.

People should be made aware of the Civil Engineering components of what is called sustainable development. This awareness programme, if it is not to descend into futile preaching, must be conducted by civil engineers by actively engaging the civil society. The Civil Engineering curricula must be reworked to make factors and ideas such as “Green” buildings, ecological footprint, embodied energy, smart materials and structures, bio-mimetic, bio-cement, etc. integral.

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Assessment of Civil Engineering Inputs for Infrastructure Development

The Indian National Academy of Engineering (INAE), founded in 1987, comprises India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines. INAE functions as an apex body and promotes the practice of engineering & technology and the related sciences for their application to solving problems of national importance. The Academy provides a forum for futuristic planning for country's development requiring engineering and technological inputs and brings together specialists from such fields as may be necessary for comprehensive solutions to the needs of the country. INAE is an autonomous institution supported partly through grant-in-aid by Department of Science & Technology, Government of India. It is the only engineering Academy in India. INAE represents India at the International Council of Academies of Engineering and Technological Sciences (CAETS), USA and is one of the member Academies of CAETS.

Among other things, studies on important/topical national issues are undertaken by the Academy through specially constituted Study Groups/ Task forces. The objective is to bring out a comprehensive/exhaustive document covering review of existing international and national technological and commercial aspects, analysis of options, future trends and specific implementable policy/recommendations and methodology of execution. Separate Task Forces have been set up by the Academy to undertake Research Studies on Technologies related to the issues of National Importance. One of these studies pertains to Assessment of Civil Engineering Inputs for Infrastructure Development.

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