Geotechnical and Geoenvironmental Education in India

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ABSTRACT: This paper discusses the geotechnical and geo-environmental education and research level in various institutes in India like Indian Institute of Sciences (IISc-1), Indian Institutes of Technology (IITs-7), National Institutes of Technology (NITs-17) and other State Technical Universities of India (STUs-40). A summery of observations with respect to undergraduate (UG) and postgraduate (PG) programs of all these institutions have been presented and discussed.

1 INTRODUCTION

India has made remarkable progress in engineering and technical education over the last two decades. The growth of sanctioned intake and output of engineering graduates are shown in figure 1 & 2. Figure 3. shows the share of civil engineers in overall engineering education. Failure of few structures and rapid rate of industrialization for development of civilization has compelled man to learn and develop new technologies for construction and means for renewable and alternative source of energy. Among the civil engineers, the geotechnical engineers are supposed to play a key role in this century in India as the ideal sites for locating the structures have drastically diminished and one is forced to accept poor soil conditions for locating the modern complex and heavy structures. The present geotechnical engineer has to study the landmasses, pollution due to industries and waste disposal besides their adverse effects on strength and settlement characteristics of the soil.

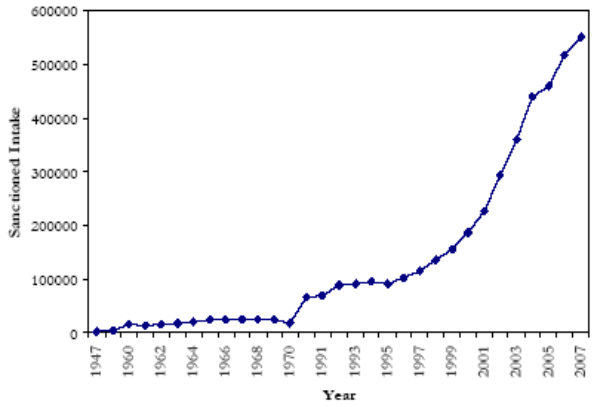

Figure 1. Growth of Sanctioned Intake of Graduates 1947-2007. (Banerjee and Muley, 2007).

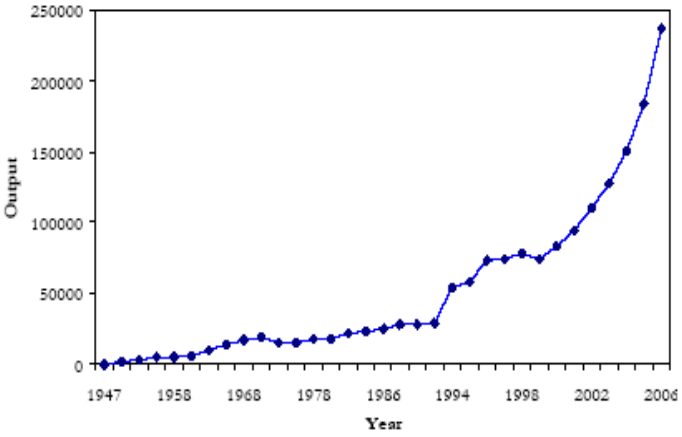

Figure 2. Total Output of Engineering Graduates 1947-2006. (Banerjee and Muley, 2007).

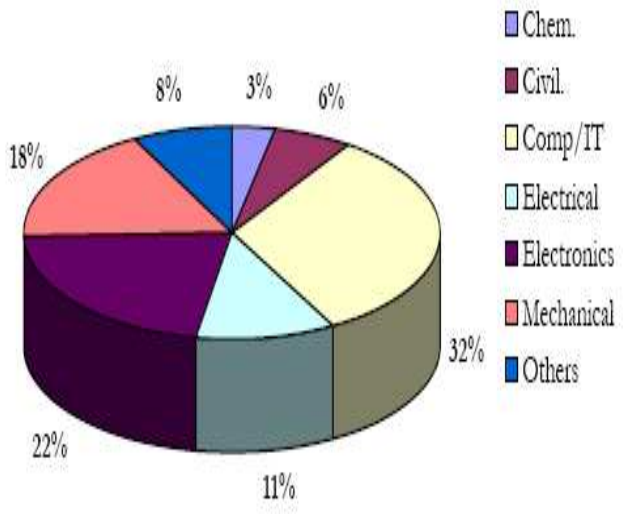

Figure 3. Discipline wise Break-up of Sanctioned Intake for Engineering Bachelors in India in 2001. (Banerjee and Muley, 2007).

In India basic soil mechanics and foundation engineering course is taught along with inclusion of two or three electives related to geotechnical engineering area at undergraduate level of four year duration covering basic and preliminary aspects. Postgraduate programme is being offered as one of the major specializations in Civil Engineering in various education systems like IITs, NITs and State Technical Universities (Khitolia, 1999). The doctorial and post-doctorial research in geotechnical engineering specialization has got international reputation with their potential recognition through publications in national and international journal and conferences and very strong professional society (Indian Geotechnical Society). This paper presents current developments in geotechnical and geoenvironmental education in Indian engineering institutes.

2 STRUCTURE OF GEOTECHNICAL AND GEOENVIRONMENTAL EDUCATION

2.1 *Three tire education system in India*

Indian Institute of Sciences (IISc. Bangalore) and Indian Institute of Technologies (IIT Kanpur, IIT Bombay, IIT Madras, IIT Delhi, IIT Kharagpur, IIT Guwahati and IIT Roorkee) are actively working on geotechnical engineering subject at the level of education and research. Particularly IIT Delhi has changed their post graduate programme in M. Tech Geotechnical engineering to M.Tech Geotechnical and Geoenvironmental Engineering considering the increasing importance of Geotechnical applications in dealing with the environmental problems like landfills, contaminated site remediation technologies etc.

One of the main core courses of the civil engineering education is Geotechnical Engineering. There are several stages of this education, one can climb and ladders upto doctoral and post-doctoral level in higher learning technical institutes, like IISc, IITs, and NITs and other state engineering universities in India. Apart from these institutes there are several research institutes and civil engineering industries that are being part of development of the research in this education. Some consultancy firms are bringing the geotechnical education as part of both professional as well as educational developments happening in this area in India. Laboratory exposure is also being maintained along with the lecture, tutorial and particles of the subject. The practical exposure is very extensive even at undergraduate level itself. The geoenvironmental laboratory exposure is given to the students at post graduate level. The experimental based research is very intensive at IISc and few IITs at doctorate and post doctorate level in India.

The Environmental Geotechnology education has been initiated in few National Institute of Technologies like Motilal Nehru National Institute Technology, Allahabad, National Institute of Technology, Calicut. They have introduced M.Tech. Environmental Geotechnology courses for the first time in India. Jawaharlal Nehru Technological University, Hyderabad has also started their PG course in Environmental Geotechnology. This changing scenario of Geotechnical Education in India is leading to a better involvement and address of development of societal issues like open dumps, water management and disaster management problems more effectively.

2.2 *Design of Curriculum for Under Graduates*

The basic geotechnical engineering education is generally introduced in the 5^{th} semester of four year course duration in majority of the institutes and with few institutes introducing it in the 4^{th} semester. Apart from this, basic soil mechanics and foundation engineering knowledge, few elective courses are being introduced. Some of the geotechnical engineering courses offered as electives are,

Advanced Foundation Engineering
Ground Improvement Techniques
Constitutive Modeling of Soils
Machine Foundation Design
Dynamics of Soils and Foundation
Soil-Structure Interaction
Rock Mechanics and Tunneling

2.3 *Design of Curriculum for Post Graduates*

The master's degree program in geotechnical engineering encompasses soil mechanics theory and applications in the fields of foundation and soil engineering. Course work emphasizes the engineering behavior of soil, soil property determination, and the use of advanced soil mechanics theory and soil-structure interaction in the solution of soil and foundation engineering problems. Elementary courses in soil mechanics, statics, strength of materials and fluid mechanics are required as prerequisites for graduate core courses. PG level teaching at IITD stress up on the applications of finite element solutions of geotechnical problems. The course designing is done in such a way that one year duration is dedicated to solution of theses problem. IIT Delhi offers specialization in Rock Mechanics in PG scheme. It has well equipped laboratory especially in this area of specialization. Also extensive research has been considered during past few years. Apart from the teaching they are serving for nation by carrying quality consultancy activities. Indian Geotechnical Society is major professional body of geotechnical engineering specialization in India. It is a forum at which all ge-

otechnical experts get the opportunity to share their research thoughts and improvements in curriculum.

Following are the some of the core courses in IITs.

Advanced soil mechanics
Advanced foundation engineering
Foundation engineering
Soil Dynamics
Soil Dynamics and Earthquake Engineering
Experimental Soil Mechanics
Soil Behavior
Rock Mechanics

One of the most important aspects in the development of a geotechnical engineer is direct experience of the soils and rock, which are the very basis of the profession. Handling these natural construction materials and their response to external loads coming on them is very important for effective design of foundation systems. Laboratory part of the course is well designed. Laboratory classes are providing the desired experience through experimentation in the Indian institutions by spending 4 to 6 hours in a week in the laboratory and field.

For the understanding purpose, the deep research interest taken in Ph.D programmes, Indian Institute of Technology, Kanpur has been taken as an example (Figure 4). A considerable number of M.Tech theses have been completed so far in geotechnical engineering specialization.

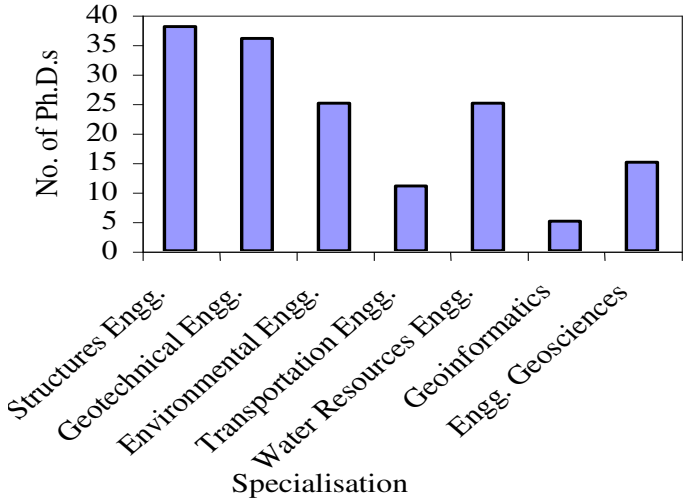

Figure 4. Number of Ph.D.s awarded up to 2006 in Indian Institute of Technology, Kanpur.

3 DEVELOPMENT OF ENVIRONMENTAL GEOTECHNICHLOGY EDUCATION

IIT's and NIT's have occupied significant research output in the environmental geotechlogy area. IISc, IIT Bombay, IIT Delhi, MNNIT Allahabad, NIT Calicut, NIT Surathkal, NIT Warangal, JNTU Hyderabad, M.S.U. Vadodara, have shown potential research interest in this area of specialisation and in development of teaching curriculum of this subject.

4 CONCLUSIONS

The main conclusions of the study are as follows:

Generally, geotechnical engineering subject is being taught at U.G. level of Civil Engineering discipline as fully credited compulsory course at IITs, NITs and other state universities. Apart from this other courses of importance such as advanced foundation engineering, rock mechanics, soil dynamics etc. are taught as electives at the fourth year level. These courses are giving basic knowledge for students who are opting environmental geotechnology course either as electives at UG level or at PG level. The growing scenario of environmental problems diverting the attention towards the Geo-environmental area has resulted in inclusion in both UG and PG level at all above mentioned institutions. Subjects like Environmental Geotechnology, Waste Management, Landfill design, Remediation of Contaminated Sites etc. have already been introduced as elective courses listed at UG level.

As the part curriculum in Civil Engineering related geotechnical engineering experiments on soil are also being taught in well designed laboratory courses in the 3rd year of UG courses. The part of environmental geotechnics is more or less an introduction at undergraduate level in geotechnical course. IISc and IITs are at par with international standards at their PG and research levels especially in geotechnical engineering specialization. The education standards in geotechnical engineering at PG level mostly focuses on behaviour of soil at micro and macro structure. Modern theories and numerical tools for modeling complex behaviour is emphasized. The state of art research capability already exists in IISc and IITs. Environmental Geotechnology area is being rapidly picked up at IITs and NITs. The research contribution from IISc, IIT Bombay and IIT Delhi in the area of Environmental Geotechnology is considerable and reaching world class level research. Geotechnical and Geoenvironmental Education in the IITs, NITs and other university system is presented in Figure 5.

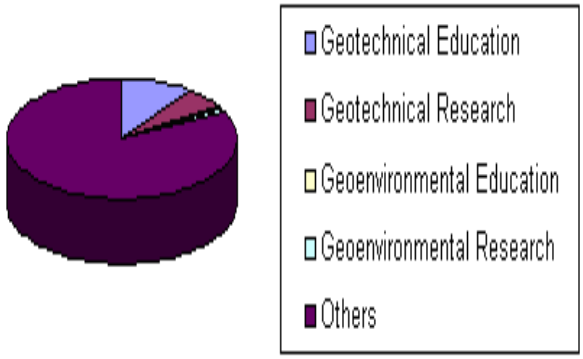

Figure 5. Geotechnical and Geoenvironmental Education in Indian Education Institutions.

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