A Report on the Workshop on Earthquake Engineering Curriculum for UP Polytechnics 29-30 July 2003 at IIT Kanpur

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Introduction

In the combined Uttar Pradesh and Uttaranchal region, nearly 80% of the area is prone to strong seismic shaking (i.e., MSK intensity VII and above). The response of many buildings in the past earthquakes has been largely unsatisfactory and has caused very significant loss of life and property. To reduce earthquake risk, efforts are required on many fronts.

Development of skillful human resource in earthquake resistant constructions is an essential step in reducing earthquake vulnerability of the built environment. Engineers responsible for design and construction should be competent in earthquake technology for a successful earthquake risk mitigation program.

Unfortunately, earthquake engineering has been mostly ignored in the civil engineering curricula of diploma and degree courses in the country. As a result, most engineers responsible for design and construction of structures do not receive any formal training in earthquake resistant construction. This situation needs to be reversed by introducing earthquake engineering topics in the existing civil engineering curricula.

The process of modifying syllabus is complex and sensitive as it is linked to various aspects of the existing delivery system. The curriculum changes must be tailor made for individual situations (e.g., Murty et al. 1998; Jain and Sheth 2002). A two-day workshop was organized during July 29-30, 2003 at IIT Kanpur to discuss various aspects of an earthquake engineering curriculum for polytechnics of Uttar Pradesh (UP). The workshop was sponsored by the National Program on Earthquake Engineering Education (NPEEE). The Institute of Research Development and Training (IRDT), Kanpur is responsible for curriculum development of polytechnics and the workshop was jointly organized by IIT Kanpur and IRDT Kanpur. The workshop was attended by civil engineering teachers of polytechnics and engineering colleges in UP as well as officials at IRDT and UP Board of Technical Education. One faculty from a polytechnic in Uttaranchal also participated in the workshop.

The workshop first reviewed the system of polytechnic education in UP and the existing curriculum to identify its weak and strong points and then focused on the aspects related to earthquake engineering education. A review of overall system was necessary because a good earthquake engineering education cannot be ensured if the overall delivery system is in poor condition. Later in the workshop, the discussion primarily focused on development of earthquake engineering curriculum, the strategy and specific requirements of resources and training of teachers for its implementation.

Polytechnic Education System

Polytechnic education system in UP is administered through Department of Technical Education (DTE) and Board of Technical Education (BTE). The curriculum for 3-year Diploma program is prepared by Curriculum Development Cell (CDC) of Institute of Research Development and Training (IRDT). In addition, there are two autonomous Diploma programs: at Aligarh Muslim University (AMU) and Institute of Engineering and Rural Technology (IERT), Allahabad.

There are about 99 polytechnics in the state of UP and only 36 of them offer Diplomas in Civil Engineering. A majority of them (about 50) are government funded, 19 are government aided and 22 of them are private. None of the private polytechnics have civil engineering program. In the state of Uttaranchal (UT), out of 15 polytechnics only 9 offer civil engineering program.

In addition to general Diploma in Civil Engineering, there are three more Civil Engineering Diploma programs which separately provide specialization in Rural Engineering, Environmental Pollution and Control and Water Resources, respectively. These specialisations basically imply that the student does an extra course on the specialization topic over and above the regular Diploma curriculum. Typical intake for a Polytechnic is 30 students per year and admission is made through a state-wide Joint Entrance Examination (JEE). On average about 20 students finish the program and graduate. At the University Polytechnic (AMU) the yearly intake is 120 in the Diploma program of Civil Engineering whereas 30 students are admitted to another Diploma course in Drafting and Designing (Civil). The University Polytechnic (AMU) also offers an advanced Diploma in the area of Environmental Engineering; another such Diploma in Constriction Management is to be launched from the next session.

At present Polytechnics are under-staffed and only about half of the sanctioned positions (about 100) in civil engineering are filled up. Most of polytechnic teachers have completed 4-year degree program in civil engineering and about 2-3 of them have received masters' degree too. Government polytechnics can recruit only through Public Service Commission, Allahabad whereas government-aided polytechnics can do so directly. The cadre of Assistant Lecturers (with Diploma as their basic qualification) has been discontinued and no new recruitments is taking place at this level. The faculty situation at University Polytechnic (AMU) is much better; with 19 teachers, all holding masters' degree and couple of them with doctorates too.

The shortage of teachers is currently being met through guest lecturers that are hired on per period basis. This very temporary arrangement does not evoke necessary commitment and sincerity required of the teaching assignment. The workshop participants were unanimous that (a) the vacant slots of faculty positions should be filled in urgently, (b) pending the recruitment of regular faculty, the ad hoc arrangement should be for one academic year on a contract basis rather than per period basis, and (c) the sanctioned strength of teachers in the polytechnics may itself need to be increased. It was also felt that for optimal utilization of faculty and laboratory facilities, Diploma programme in Civil Engineering may be consolidated at a fewer polytechnics but not affecting the total student intake at the state level.

The pattern of course administration is annual and the examination is held at the end of year in a centralized manner administered by BTE. Students are awarded marks as opposed to letter grades. A semester program with multi-point entry and credit system is also currently in practice in 4 polytechnics where BTE conducts exams at the ends of each of six semesters of the program. It was felt that the semester programme is far more effective and that the state must

move its polytechnic programmes to the semester programmes. It was felt that the examination work in the semester programme may not be significantly larger than the current examination work, even though some modifications in the administration of the examination may be needed.

Existing Civil Engineering Curriculum

The current curriculum is in practice since 1996. A new curriculum with relatively minor modifications has been developed which will be implemented from this year. In the proposed curriculum there are 27 courses and 3 lab courses in addition to project work and field exposure. A few courses also have lab associated with them, in addition to 3 lab courses. A typical load is 48 periods per week (each period is 50 minutes, i.e., about 40 contact hours). Out of 32 weeks of academic year, at least 25 weeks should be spent on effective teaching. A summary of courses of civil engineering curriculum is given in Table I.

The curriculum has no provisions for electives and lacks courses in humanities. Workshop participants also expressed concern that due to the annual system, some courses have too little while others have too much course contents. Such anomalies can be effectively dealt with in the Semester Programme which provides a lot more flexibility.

Medium of instruction is mostly in Hindi and a very small number of students take their exam in English. A few textbooks for each of subjects in the curriculum are available in Hindi. However, participants felt that these books lacked depth and were inferior to their counterpart textbooks in English for degree colleges.

Table I: Current Structure of Courses for 3-Year Diploma in Civil Engineering in UP Polytechnics

Year I		**Year II**		**Year III**	
Subject	*Hours per week (L-T-Lab)*	*Subject*	*Hours per week (L-T-Lab)*	*Subject*	*Hours per week (L-T-Lab)*
Professional Communication	3-0-2	Elements of Elect. & Mech. Engineering	3-0-0	Design of Steel and Masonry Structure	3-0-0
Applied Math I	3-1-0	Strength of Materials	3-1-2	Design of Reinforced concrete Structures	3-1-0
Applied Physics	3-1-2	Hydraulics	3-1-2	Highway, Railway and Bridge Engineering	3-1-0
Applied Chemistry	3-0-2	Public Health Engineering	3-0-2	Estimating, Costing and Valuations	2-2-0
Applied Mechanics	2-1-1	Soil Mechanics and Foundation Engineering	3-0-0	Construction Management, Accounts and Entrepreneurship Development	3-0-0
Engineering Drawing	0-0-8	Bldg. Construction & Maintenance Engineering	3-0-0	Surveying II	3-0-8
Introduction to Computer	1-0-3	Concrete Technology	2-0-0	Civil Engineering Drawing II	0-0-8

Workshop Practice	0-0-8	Civil Engineering Drawing I	0-0-8	Irrigation Engineering	3-0-0
Building Materials	2-0-0	Surveying I	2-0-4	Environmental Pollution and Control	3-0-0
Civil Lab I (Building Material Testing Lab)	0-0-2	Civil Lab II (Building Construction & Maint.; Concrete Tech.; Soil Mech.)	0-0-6	Civil Lab III (RCC and Highway)	0-0-2
				Project Work	-
				Field Exposure	-
				Specialization (Optional)	(3)
Total	**48**		**48**		**45 (48)**

Earthquake Engineering in Curriculum

It was heartening for the authors to note that in the curriculum recently finalized for implementation starting this year, the Earthquake Engineering topics have already been introduced; this shows commitment of the polytechnic system in UP toward introducing earthquake engineering topics in the curriculum. Under the subject "Building Construction and Maintenance Engineering" of Year II, a topic titled as "Concept of seismics in planning and design of buildings" is to be devoted a total of 4 lectures. The contents of the topic is described as below:

Introduction to earthquakes
Magnitude and intensity
Seismic zoning
Precautions to be observed in the design and
Seismograph

Clearly, the amount as well as contents of exposure to earthquakes is far from satisfactory and is unlikely to impart any useful insight and understanding to the students on earthquake resistant construction. It is realized that the course contents have to be expanded and more time should be devoted to it.

For introduction of earthquake engineering contents, two different models were debated during the workshop: (i) Model 1: Introducing a separate self-contained course with appropriate topics of earthquake engineering and (ii) Model 2: Introducing earthquake engineering contents into relevant existing courses.

Both options have their pros and cons. It was generally felt that the Model 2 would be better in the long run, as it helps to integrate earthquake engineering with civil engineering education and does not give an impression that earthquake engineering is a specialty topic. However, Model 1 has several advantages over Model 2 in the short run from the implementation point of view:

- In Model 2, several teachers have to be proficient in earthquake engineering to do justice to the contents, whereas in Model 1, only one teacher at a given polytechnic needs to be

trained and developed to teach the course. Clearly the effort required for a reasonably effective delivery is much less for Model 1.

- Textbooks currently available for different courses do not cover related earthquake engineering topics which may hamper proper implementation of Model 2.
- If the earthquake engineering contents are introduced in the existing courses, it is likely that the teachers may not cover those since they lack expertise and the concerned text books do not provide the coverage.
- A good feedback system for the earthquake engineering contents can be developed for further improvement if Model 1 is followed.
- A single and separate course in earthquake engineering emphasizes its need and importance to the students and teachers alike whereas in Model 2, the effect is more likely to go diffused.

Though most participants preferred Model 1, they did not want to remove any existing course. The course on earthquake engineering can only to added in Year III because it requires background in reinforced concrete and masonry structural design. As seen in Table I, these design courses are taught in Year III. It was felt that though it is less than ideal but there are no options in the yearly conduct of courses, as these design courses cannot moved to Year II. Moreover, the curriculum can not be loaded beyond 48 periods per week in any Year, and at least two periods per week were needed to do justice to the subject.

During the discussions, it emerged that the course on Environmental Pollution and Control (EPC) is relatively light in contents, and the topics therein can be taught in 2 periods per week instead of the allocated three. Similarly, the participants felt that the contents of Highway, Railway and Bridge Engineering (HRB) can be adequately covered in 3 lectures per week as against 4 lectures per week currently assigned. The two periods per week saved in this manner were used to introduce a new course on Earthquake Engineering in Year III.

A draft syllabus for the new course on earthquake engineering was discussed. There was a consensus that the course contents should emphasize the basic concepts of earthquakes, their occurrence and effects on structures, role of site soils, earthquake resistant construction of masonry and reinforced concrete structures including architectural planning, and retrofitting. Certain topics such as structural dynamics, which are more mathematical in nature, should be discussed qualitatively and only results that are necessary to understand the behavior of structures during earthquakes need to be stressed. Further, it was felt that construction aspects of structures are most important and should be emphasized. Based on these discussions and considering the primary objectives of the course, the syllabus for this new course was developed as per Table II. With this modification, the existing topic of "Concept of seismics in planning and design of buildings" in the course "Building Construction and Maintenance Engineering" of Year II will be dropped.

Further, it was decided that the students should spend at least two sessions in the computer laboratory to study through CDs and internet different types of damages sustained in the past earthquakes. Also, in the course on Civil Engineering Drawing II, they should be asked to make one drawing of a small masonry building with earthquake resistant features.

Table II: Syllabus for the course in Earthquake Engineering

S. No.	*Topics*	*Hours*
1	Causes of earthquakes and seismic waves, magnitude, intensity and energy release, Basic terminology, Characteristics of earthquakes, Seismic hazard, vulnerability and risk, Seismic zoning.	8
2	Earthquake performance of structures in past earthquakes	4
3	Philosophy of earthquake resistant design and concept of ductility, Short and long period structures, Concept of spectrum, Static force calculations.	4
4	Architectural considerations: Building simplicity, symmetry, irregularities, continuity and uniformity	4
5	Effect of soils and liquefaction, remedial measures, construction of earth structures	4
6	Seismic construction of masonry buildings, provisions of IS:4326	10
7	Seismic construction of RC buildings, detailing provisions of IS:13920	12
8	Retrofitting of masonry and reinforced concrete buildings	4
Total		**50**

Implementation Issues

For implementing the proposed course on earthquake engineering, two serious obstacles were identified: (a) lack of adequate expertise of teachers in the area of earthquake engineering, and (b) lack of teaching materials such as textbooks, reference materials, etc. A training of a couple of teachers from each polytechnic with civil engineering program is urgently needed for effective implementation. Considering the operational constraints, it emerged that only short term, such as one week long, training is feasible. IRDT will coordinate these training programs which can be conducted at institutions such as IIT Kanpur and IIT Roorkee.

For resource materials, IRDT will do necessary research at the library collections of textbooks, reference materials in print and in electronic media at National Information Center of Earthquake Engineering (NICEE), IIT Kanpur. A specific program on resource materials in earthquake engineering is being organized at IIT Kanpur in the last week of August, and it is hoped that IRDT will take this opportunity to build the resource materials that can be sent to all polytechnics. It also became obvious that writers of the currently used text books in UP polytechnics should be encouraged and helped to prepare textbooks on earthquake engineering for diploma students keeping in mind the new syllabus.

The computers can be used very effectively to teach not only the earthquake engineering but many other courses. Many interactive programs and educational tools are available which provide hands-on experience and manipulation to understand fundamentals and explore further applications. The experience with programs such AutoCad used extensively in the industry can add tremendous value to the students with respect to job potential, and this too requires

computational infrastructure. Hence, the participants felt that the polytechnics need to develop a computational laboratory in the civil engineering departments.

Recommendations

Detailed discussions during the two-day workshop concluded that adequate exposure of Diploma students to fundamentals of earthquake engineering requires changes in curriculum and fresh strategies of teacher training and development of teaching resource materials for an effective implementation. Following recommendations emerged out of the deliberations held during the workshop:

1. The recently introduced contents of earthquake engineering topics were found inadequate and these should be replaced with a full course on earthquake engineering in Year III. The contents of this two-lectures per week course will emphasize the concepts of earthquake-resistant construction and its practical aspects related to field supervision and execution.

2. Training of teachers in the area of earthquake engineering is essential for successful implementation of the course. It is recommended that at least two teachers per polytechnic go through at least a one-week training at institutions such as IIT Kanpur and IIT Roorkee.

3. Easy availability of teaching resource materials is very crucial for effective delivery. Writers of current textbooks should be encouraged to write textbooks on earthquake engineering. IRDT should play a major role in collecting relevant materials from NICEE at IIT Kanpur and other places and distributing to polytechnics.

4. A computational laboratory needs to be developed in every civil engineering department for effective training in not just earthquake engineering but also in other subjects of civil engineering.

5. Currently, the polytechnics of Uttaranchal follow the same curriculum as that in UP. Hence, the recommendations on curriculum changes developed during the workshop may be useful for curriculum changes in Uttaranchal state also.

It was recognized an effective delivery of earthquake engineering is possible if the overall system is healthy and has proper mechanisms and facilities in place. A review of overall polytechnic education with focus on civil engineering led us to identify its various strength and weaknesses. It is important to exploit the strengths further to improve the quality and relevance of the courses and the program, but it is equally necessary that various constraints and obstacles in the path of effective implementation are removed as soon as possible. Some further recommendations to improve overall conditions, which came out during the workshop, can be summarized as below:

1. The modern curricula are generally organized in semester system, which provides the flexibility to the overall structure of courses, compactness of course contents and focused attention during the course delivery. The yearly conduct of the program should be changed to semester system.

2. The shortage of civil engineering teachers needs to be addressed rather urgently. Temporary guest lecturers cannot do justice to teaching professional courses. A long-term

commitment is essential and at least one-year appointment on the contract basis should be given. Efforts should be made to fill up the vacant positions as soon as possible.

3. Currently, too few teachers in UP polytechnics have Masters degree. For instance, there is a clear contrast in this regard with the University Polytechnic (AMU). It is important to provide opportunities and incentives to the existing teachers for upgradation of their qualifications.

4. Currently a few teachers are responsible for teaching too many diverse courses. As a result, they are not able to acquire the required depth in these subjects and that affects a good teaching. Sanctioned strength of teachers at these polytechnics needs to be increased. If required, the programs can be consolidated at a fewer polytechnics. In other words, without reducing student intake, the civil engineering program can be run at fewer places with enhanced resources.

5. Computers can be effectively used for teaching many courses and also for imparting skills that would be useful to industry. It is recommended that more computers along with necessary software programs be made available at polytechnics to keep in sync with changing industry requirements.

6. Diploma curriculum in Civil Engineering should have more electives and courses in humanities and management. The curriculum should have strong coverage of subjects that impart most important skills, such as surveying, estimating and costing, construction methods, concrete technology, drawing & detailing, maintenance, etc.

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References

1. Murty, C. V. R., Sinha, R. and Jain, S. K., "A Report on Earthquake Resistant Construction in Civil Engineering Curriculum," **Newsletter of the Indian Society of Earthquake Technology,** January 1998, pp 1-10.

2. Jain, S. K., and Sheth, A., "Earthquake Engineering in the Civil Engineering Curricula," **The Indian Concrete Journal,** Vol.76, No.9, 2002, pp 558-562.