Earthquake Engineering Concepts in the Curriculum of Architectural Diploma Courses of U.P. Polytechnics

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Introduction:

In view of the earthquake risk in the country, it is important that students of architectural colleges are taught principles of earthquake engineering. A one day workshop was conducted on 11 October 2004 at the Indian Institute of Technology Kanpur to discuss the various issues related to introduction of earthquake engineering concepts in the curriculum of diploma for architectural assistants courses in the polytechnics of Uttar Pradesh (UP). The workshop was sponsored by the National Programme on Earthquake Engineering Education (NPEEE). The Institute of Research Development and Training (IRDT), Kanpur is responsible for curriculum development of Polytechnics in Uttar Pradesh.

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. Also a brief discussion took place on the job prospects of the students after they complete the diploma programme. 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 the Institute of Research Development and Training (IRDT), Kanpur.

There are three polytechnics for architecture under the DTE, two at Lucknow, and one at Kanpur. The annual intake for the polytechnics at Lucknow is 50 students while that for Kanpur is 40 students. Admission to the diploma course is made through common entrance test of engineering, no separate aptitude test for architecture is conducted. The minimum qualification required is high school with science.

Department of architecture in a polytechnic is typically expected to have one head of the department, two lecturers with architectural background and one with background of civil engineering. At present the polytechnics are under-staffed and the shortage of teachers is currently being met through visiting lecturers. The workshop participants were unanimous that the vacant slots of faculty positions need to be filled in urgently in the interest of quality education.

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The pattern of course administration is annual in the Government Polytechnic, Lucknow and semester in Government Girl's Polytechnic, Lucknow and Dr. Ambedkar Institute of Technlogy for Handicapped, Kanpur. In the semester pattern, courses are split into semester A and semester B. The semester program allows multi-point entry. This gives flexibility and the student can graduate in two and half year instead of three by taking extra courses.

Existing Architectural Curriculum:

Architectural assistantship originally was a drafting course designed for developing assistants to architects. But now it has become a degree-like program with common courses of civil engineering. It has a syllabus for diploma in architecture even though it is called diploma in architectural assistantship and the emphasis on drawing has been reduced while courses in physics, chemistry, mathematics and civil engineering have been increased.

Revision of the curriculum was done two years back and is effective from the session 2002-2003. In the proposed curriculum of annual pattern there are 24 courses in addition to the project work and field exposure. A typical load is 48 periods per week. Each period is of 50 minutes durations. Out of the 32 weeks, atleast 25 weeks should be of effective teaching in an academic year. In the semester pattern, out of the 16 weeks, atleast 14 weeks should be of effective teaching.

The curriculum has common courses with civil engineering, like Physics, Chemistry and Mathematics. Structures courses are considered heavy by the students. Also, there is lack of laboratory. The curriculum has no provision for electives. Recently, environmental science course was introduced in the curriculum but without exams and credit.

In a studio class, 50 students work together with only one teacher supervising which is not very effective. Hence, more teachers are needed so that the students can be divided in two batches.

Methodology:

A considerable amount of discussion took place on the appropriate methodology for introduction of earthquake engineering in the curricula of architecture. At present the students receive no inputs on earthquake engineering.

It was agreed unanimously that introducing earthquake engineering at the studio level alone was not adequate. The earthquake concept should be incorporated in a separate course and studio exercise on earthquake resistant design should be the part of architectural design. Thus, it appeared necessary to take up earthquake engineering at two levels, at the course work level and in the studio.

It was decided that earthquake engineering should be taught as a separate course with one lecture per week in the final year of the annual pattern and two lectures per week in the fifth semester of the semester pattern. Knowledge of the subject should be incorporated while designing the buildings in the studio programs. Also, it was proposed that one design problem with particular emphasis on earthquake design shall be taken up in the sixth semester. It was decided that there should be an exam of 50 marks with sessional of 20 marks.

Implementation of Syllabus Changes:

All the teachers expressed their enthusiasm in introducing earthquake engineering in the curriculum. A syllabus for earthquake engineering was developed based on the discussions (Annexure A).

The curriculum changes must be accompanied with resource materials and resource persons. A number of books and other resource materials are available. A few of these are mentioned hereunder:

- IITK- BMTPC Earthquake Tips is a project for twenty four tips of two pages each, written in simple language. These are available at www.nicee.org for anyone to download. These are very suitable for teachers and students of polytechnics. Hindi translation of the Tips are expected to become available shortly.

- Guidelines for Earthquake Resistant Non-Engineered Construction is a publication of the International Association for Earthquake Engineering. This is written in a very simple language targeted at a common man. Soft copy of the same is available at www.nicee.org. Limited number of paper copies may be available free of charge from the National Information Center of Earthquake Engineering (NICEE) and can be requested through an email to nicee@iitk.ac.in. Separate Hindi and English versions of the same are available.

- A number of reports on past earthquakes are available on internet. NICEE web site has materials on all past earthquakes in recent years in India. NICEE is also distributing of charge two CDs on the Bhuj earthquake: one containing a four hundred page report on a multidisciplinary investigation of the earthquake, and the other containing annotated images of the earthquake for easy presentation.

- Recently, the book by Stratta has been reprinted in India and is now available at a very reasonable price. This is a good material for architects since it contains a lot of pictures and discussions of damages in the past earthquakes, and the entire book is written in simple language.

- There are some publications developed by architects for architects published by international publishers (e.g., Arnold and Reitherman 1982, Lagorio 1990, AIA1994).

The National Programme on Earthquake Engineering Education (NPEEE) has provision for training of faculty of architecture. Hence, this avenue could be effectively used by the polytechnics in UP and elsewhere to have some of their faculty members trained in earthquake engineering. Already, one such programme has been conducted by the Department of Architecture and Planning at Roorkee, and more such programmes are being organized.

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Annexure A: Course on Earthquake Engineering (28 lectures)	
Topics	**Lectures**
1. Nature and characteristics of ground motion Consequences of earthquake ▪ Ground Rupture and Ground Failure ▪ Liquefaction ▪ Land Slides, etc. Ground Motion ▪ Fire ▪ Tsunamis	**2 Lectures**
2. Engineering seismology Structure of the Earth Plate Tectonics Evolution of Indian subcontinent Waves generated by ground motion and their characteristics ▪ Body Waves o Longitudinal waves o Transverse waves ▪ Surface Waves o Rayleigh waves o Love waves ▪ Attenuation of waves Distribution of earthquakes ▪ Global ▪ Indian Measurement of earthquake ▪ Introduction of instruments used for measuring earthquakes o Seismograph o Accelerograph ▪ Various scales of Magnitude ▪ Various scales of Intensity Basic Terms ▪ Fault line ▪ Focus ▪ Epicentre ▪ Epicentre distance ▪ Focal depth ▪ Peak ground acceleration, etc. Seismic Zoning and Micro-zoning	**4 Lectures**

3. Behaviour of buildings during earthquake Ground motion and earthquake forces Siting of structures Typology and Classification of buildings ▪ Load bearing masonry walls o Brick masonry o Stone masonry o Mud ▪ Reinforced Concrete Buildings o RC framed building o RC shear wall building o Dual system building ▪ Steel Buildings Dynamic characteristics of building and its relation with built form ▪ Symmetry ▪ Regularity ▪ Stiffness ▪ Flexibility ▪ Strength ▪ Time period ▪ Damping ▪ Ductility ▪ Material and method of construction, etc. Earthquake resistance of various forms of building ▪ Configuration o Scale of building o Size in horizontal plane o Size in vertical plane o Building proportions o Symmetry of the building o Reentrant corners o Redundancy, etc. ▪ Irregularities in building o Horizontal plane o Vertical plane ▪ Building corners o Outward corners o Inward corners Special Aspects ▪ Torsion ▪ Appendages	**10 Lectures**

▪ Staircases ▪ Pounding ▪ Repair and maintenance ▪ Construction management	
4. Behaviour of nonstructural elements in the building during earthquake	**3 Lectures**
5. Soil characteristics and its impact on various built forms during earthquake	**1 Lectures**
6. Philosophy of earthquake resistant design of buildings	**2 Lectures**
7. Earthquake resistant features and use of IS 4326 for masonry buildings	**3 Lectures**
8. Introduction to ductile detailing of RC buildings as per IS 13920	**3 Lectures**