



Integration of Seismic Resistant Design & Construction

into

the Curricula of

the Diploma in Associate Engineering - Civil: An Action Plan

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ACRONYMS

AJK	Pakistan Administered State of Azad Jammu & Kashmir
DAE	Diploma of Associate Engineer
ERRA	Earthquake Reconstruction and Rehabilitation Authority
GCT	Government College of Technology
NAVTEC	National Vocational and Technical Education Commission
NDMA	National Disaster Management Authority
NISTE	National Institute of Science and Technical Education
TEVTA	Technical Education and Vocational Training Authority
UET	University of Engineering and Technology

1. INTRODUCTION

The objective of this Mission was to develop an Action Plan for the incorporation of seismic resistant design and construction into the Diploma of Associate Engineer (DAE) (Civil) in Pakistan. This need became evident after the Kashmir Earthquake on October 8th 2005, when the vulnerability of people and the buildings they occupied were fatally exposed. While the significant proportion of that vulnerability was borne by those in rural areas living in non-engineered houses, which Rafeeqi suggests are responsible for 75% of all earthquake casualties, The earthquake also impacted on provincial urban areas such as Muzaffarabad and Balakot and even in the metropolitan area of Islamabad with the collapse of the 10 storey Margalla Towers building (Rafeeqi, 2007).

Pakistan is a seismically active country. It's seismic zoning recognizes several areas of significant seismicity that includes the Pakistan Administered State of Azad Jammu and Kashmir region where the October 2005 earthquake was centred. This earthquake and another in 1935 in Quetta are listed in the world's top 10 earthquakes disasters in the last 100 years in terms of death toll despite their comparatively small Richter Scale magnitude of 7.6 and 7.7 (USGS, 2009). In addition, both were centred in rural and remote areas of Pakistan and besides the significant death toll the 2005 Kashmir Earthquake also left 3.5 million people homeless. This vulnerability was repeated albeit on a reduced scale by another earthquake in October 2008 when a 6.4 earthquake caused 215 deaths and made 15,000 people homeless in the province of Baluchistan. During the field work for this mission in February 2009 a much smaller 5.5 earthquake injured 33 people and caused damage at 3 local schools in Muzaffarabad. This was a very minor seismic event still caused injuries and damaged buildings.

All of this underlines the vulnerability mentioned earlier and the need, as part of an integrated plan that includes masons and rural home owners, for seismic design and construction to be incorporated in the engineering curricula to raise both technical standards and social awareness.

The specific targeting of the Diploma level is in response to the rural/remote nature of this vulnerability. Diploma level Associate Engineers are more likely than degree level engineers to be involved in such house construction but less likely than local masons. Hence the targeting of both groups is necessary to address the issue highlighted by Rafeeqi of non-engineered buildings. Associate Engineers will be involved in the site construction of public buildings such as schools and hospitals which also performed poorly in the Kashmir Earthquake and increasingly for larger privately owned buildings in provincial and metropolitan centres throughout Pakistan. This uptake of Associate Engineers will be accelerated by the anticipated publication of Pakistan's seismic code which is based around the Uniform Building Code 1997 (UBC97).

Thus, targeting of the Diploma level is a strategic measure that will complement other work in standards setting with masons and artisans.

2. TERMS OF REFERENCE

The stated objectives of the Mission, comprised of a team made of an international consultant and a national technical and vocational education specialist, were as follows:

- a. Discuss with United Nations Centre for Human settlements (UNHABITAT), United Nations International Children Emergency Fund (UNICEF), Earthquake Reconstruction and Rehabilitation Authority (ERRA), National Vocational and Technical Education Commission (NAVTEC), National Institute of Science and Technical Education (NISTE), National Disaster Management Authority (NDMA), Private Sector and NWFP University of Engineering and Technology (UET) Peshawar, Government College of Technology (GCT), Peshawar on the key issues surrounding construction skills and practices related to seismic resistance construction.
- b. Review of and Discussions on existing DAE (Civil) curricula and existing building codes to assess the need for curricula revision (in the long run) and the need to develop supplementary training material (in the short run) and prepare a detailed Action Plan for implementation of curricula reform in phases. The Plan should cover:
 - i. Training of instructors/trainers in seismic resistant design and construction and roll-out.
 - ii. Assessment of equipment needs for effective delivery of the new module(s).
 - iii. Involvement of construction industry.
 - iv. Creation of linkages between GCTs and The Earthquake Research Centre of UET Peshawar to benefit from its expertise and resources
 - v. Linkages of the intervention with the ongoing and planned activities of NAVTEC, UNESCO and other UN agencies under One UN Reform.
 - vi. Implementation of the reform in other GCTs within and outside North-West Frontier Province.
- c. Advise NAVTEC and other stakeholders on strategies for development of linkages between the construction industry and GCT Peshawar as a test model.

Expected Outcomes

The two deliverables for this Mission were as follows:

- a. Detailed Action Plan for revision of DAE (Civil) curricula.
- b. A final Mission Report.

3. METHODOLOGY

The mission adopted two approaches for collection of relevant information for analysis. It started with the review of Scheme of Studies and curricula of DAE (Civil) to ascertain time allocated for different subjects & topics and existence of seismic resistant design and construction components in the current curricula. Besides, consultative meetings with various stakeholders were held to ascertain their views. The list of organizations and persons met is given as Appendix A.

The mission started with a briefing with the Manager, Education in Emergencies and Disaster Risk Management Unit and then with the Director UNESCO to benefit from their thinking on the task.

UNHABITAT has been providing training to civil engineers, Diploma engineers, and masons in seismic resistant design and construction. To benefit from their experience detailed meetings were held with their Technical Advisor and her team. Meetings were also held with ERRA officials to find out the building codes and other requirements in the context of post earthquake re-construction.

NAVTEC is an apex body responsible for policy and planning for promotion of TVET in Pakistan. The approval of skill standards and DAE curricula also fall within their purview. Hence advantage was also taken of the thinking of top functionaries and technical experts of NAVTEC and Boards of Technical Education Punjab and NWFP, regarding modalities and technical procedures for revision and implementation of curricula. A detailed discussion with concerned officials at Punjab TEVTA headquarters and heads of the institutions offering DAE (Civil) and B. Tech. (Civil) programmes was also held.

The National Engineering Services of Pakistan All Pakistan Contractors Association and Pakistan Engineering Council were consulted to ascertain the role of Diploma holding Engineers in the construction and the level of theoretical and practical knowledge of design and construction they need to possess.

Students of DAE (Civil) final were also consulted regarding their expectations of the course, future plans with respect to job and further studies.

The GCT Peshawar had been identified as the institution where programme is to be implemented to start with. Detailed discussions were held with the faculty of Civil Technology Department regarding earthquake resistant design and construction related topics in the current curricula, content and the topics of the current curricula with which new topics/content could be integrated. Requirements of theory and practical periods for earthquake resistant design and construction component and how these could be accommodated within the available time were discussed.

The Earthquake Engineering Centre of UET, Peshawar has developed programme for civil engineering graduates to equip them with knowledge and techniques of earthquake resistant construction. Besides the centre has state of the art machinery for training in earthquake resistant designing and construction. Detailed discussions were held with head of the Centre both with regard to the depth and spread of content of earthquake resistant design and construction component for DAE and possible linkages between the GCT and the Centre for implementing the programme.

A draft report developed on the basis of aforementioned deliberations and international experiences was presented in a meeting of various stake holders held in NAVTEC, Islamabad and was modified/fine tuned in the light of discussions and suggestions.

4. FINDINGS AND DISCUSSION

4.1 Key Issues Emerging From Consultative Meetings

The key issues that developed from extensive consultations and discussions with various academicians and practitioners were as follows:

- a. There were divisions over the mix of theory and practical content within the DAE. The engineering consultants and contractors felt that there should be minimal to no theoretical background, while those involved in the reconstruction work following the Kashmir Earthquake felt that there should be around 20-40% theoretical and 60-80% practical content. However, most agreed that it should not be design orientated (as suggested in the title for this Mission) but must have a substantial “details” basis.
- b. There was a division over the type of physical materials to be covered in the DAE (Civil). There was agreement that the main materials of concrete, steel and timber should be covered in the course. However, there was division between those with an academic background together with those involved in the reconstruction that masonry (which would include bricks, rocks, mud bricks and adobe) should also be included whereas those from a consulting or contractual background did not support. Such a division is understandable given that effectively all masonry buildings are non-engineered and hence do not involve consultants or contractors. On the other hand, it is where the vulnerability exists and consequently this difference represented a core concern for the Action Plan to address.
- c. Those involved in the reconstruction felt that the DAE course also needed to address seismic retrofitting and building seismic assessment.
- d. There seemed to be general agreement that home builders in the rural areas would not use an Associate Engineer and would instead use a mason/tradesperson.
- e. There were comments that if the proposed seismic component were compact and integrated into the existing DAE curricula then it would be a simple matter of NAVTEC issuing a letter for all Boards to adopt the new curricula. On the other hand if the seismic course were a new stand alone module then a review of the full curricula may need to be completed.
- f. The logic of these comments expressed by those from the Boards of Technical Education (and supported by those in the school administration and teaching areas) was that there were gaps inside the present curriculum into which the seismic component could be placed. The presence of these gaps and the small size of the proposed seismic component meant that it could be easily absorbed into the present structure. However, if it were stand alone the concern was that the gaps mentioned above and the need for a complete review of the DAE (Civil) curriculum may make the stand alone module the catalyst for such a complete review. Such a review would be relatively protracted and if one accepts the urgent need to include a seismic component into the DAE (Civil) then a standalone module was “risky”. Moreover, the feeling expressed by Board of Technical Education members was that the integrated approach could be simply ratified by a letter from NAVTEC instructing them to proceed with the proposed inclusion of the seismic component. Both Boards appeared to be comfortable to proceed on such a basis.
- g. Finally, the DAE (Civil) appears to be male dominated with “engineering” opportunities for females through the DAE (Architecture). While females are not barred it would appear that they are not culturally encouraged for enrolling into a DAE (Civil) course. This issue is outside the thrust of the TOR of this Mission

however, it would be incorrect not to mention what was observed. Women play an important role in engineering in other countries, a role only recently realized. Hence, this apparent situation of engineering is not for females while architecture is, is not exclusive to Pakistan. But the impact of this vulnerability mentioned earlier is largely carried by women and in areas where outside males are excluded means that there is a particular role for women associate engineers. The Action Plan discusses this issue further with some simple recommendations to address this issue.

Near the end of this mission there were some anecdotal comments about women doing the DAE (Civil) in the Karachi and hence the above comments may be premature.

- h. Most interesting were the responses from the students. Most had selected the DAE because they felt it had good employment opportunities. Both groups in Peshawar and Lahore expected around 12,000 rupee/month in the private sector with a little less in the Government sector when they graduate. In addition, 25% of students in the Peshawar group and 45% in the Lahore group planned to go to the Bachelor of Technology degree. The relevance of this was that the students doing the DAE (Civil) were doing it because they wanted a job and they saw the DAE route as the best way to achieve that over other options that they may have had. This was backed up by them already knowing how much they could expect to earn. Its significance was that these jobs were with the consultants and contractors and not with reconstruction. Therefore the DAE (Civil) should not include masonry as discussed earlier. In addition, the large number planning to use the DAE (Civil) as a stepping stone into a degree also supported the idea (developed later in this Action Plan) to link the curricula for the DAE (Civil) and B. Tech. degrees. Their views were significant, clear and should not be omitted.
- i. It was reported that there are 16 Government and 32 Private affiliated institutions in Peshawar and 24 and 85 respectively in Lahore that offer a DAE (Civil).
- j. Throughout these meetings there seemed to be a keen willingness to incorporate seismic design and construction into the curricula of the DAE (Civil). The issues raised above were not “show stoppers” but were raised to facilitate the overall goal of assisting those who were vulnerable and at risk. This was encouraging for this and any future Missions.

4.2 Existing Curricula, Linkages and Training

4.2.1 Existing Curricula

The present curriculum for the DAE (Civil) was formulated in 1996 and does not have any seismic component. However, the DAE (Architecture) formulated at the same time does have a small seismic section but would not be suitable for further development. Hence, a new curricula developed outside the DAE courses would be required and hence, the aim of this Mission.

The need for an overall review of the DAE (Civil) was repeated at many of the meetings. While this was due to the need to update the changes that have occurred in civil engineering since 1996 (such as the use of lasers in surveying and measurement), there was also the need

to bring the curricula in line with the diploma level of the DAE rather than the degree level it now seems to be pitched. For example, the current curricula includes dot and cross products in mathematics in year 1, differentiation of $\ln x$, $\log ax$, ax and ex in mathematics in year 2 and Darcy's and Chezy's Formula in hydraulics in year 3. Not all the courses are pitched at what appears to be degree level but it is significant. There was also a suggestion from the contractors that the DAE did not cover their area sufficiently and that they commonly find that DAE students do not know basic concepts such as "liquidated damages". Hence in summary any review of the curriculum for the DAE (Civil) will not be quick and will require an extensive rebuild from the present curriculum.

These deficiencies appear to be generally understood and the issue of a complete review is included in this Action Plan to highlight that the inclusion of a seismic component into the DAE (Civil) should not be the catalyst for such a review. As discussed later, the proposed seismic component is a small change to the existing course content. One which the Action Plan proposes should be acted on as early as possible prior to such review so that this vulnerability can be addressed but also to ensure that a seismic component, possibly as a standalone module, can be included as part of that review.

4.2.2 Linkages

Linkages with the industry, both Government and private are important. In New Zealand and Australia, the equivalent DAE (Civil) would have Industry Advisory Groups attached to them. Such groups allow engineering consultants, contractors and Government departments the opportunity to provide direct feed back as was evident in objective 1. They are a two way dialogue and with educators able to explain the constraints under which they work and invariably the Advisory Group becomes an Advocacy Group to Government and the private sector. This situation is not in place and there appeared to be minimal formal linkages between industry and the teaching institutes.

This lack of involvement of the construction industry was surprising as courses with a vocational/technical/professional basis usually seek input from and linkages with institutional and professional bodies outside of the classroom. Such linkages provide the "real world experience" that academic teaching sometimes cannot adequately provide. Developing such linkages should be included as part of a fuller review with the establishment of Industry Advisory Groups and certainly on a one to one basis initiated by teaching staff but could be incorporated and promoted in the proposed training included in this Action Plan.

The linkage between GCT Peshawar and the Earthquake Research Centre will certainly be established with the proposed training with there already being a one to one linkage. This linkage needs development beyond a simple MOU. The need to provide "real world experience" to back up the theoretical content of the seismic module requires experience beyond the normal and it is here that further linkages with the Earthquake Research Centre need to be developed. For example, the use of multimedia showing testing of commonly designed buildings and vernacular housing in Kashmir would be beneficial. Video output from programs such as SAP highlighting the impact of various bad seismic design strategies such as a "soft storey" which together with photographic examples from Pakistan (and then perhaps similar examples from other countries) would also be effective teaching aids. Thus, there is much that could be readily developed and perhaps posted on the web for down load by Institutes.

The other linkages mentioned in the TOR between NAVTEC, UNESCO and the One UN will come from the development of the Action Plan. UNHABITAT appear keen to build on their post disaster reconstruction experiences in Kashmir and the NWFP and have a keen interest in the training and text book aspects of the Action Plan. NAVTEC have also been suggesting a standalone module instead of the integrated option and have indicated that this should not be as problematic as earlier hinted. These represent significant linkages for UNESCO to follow through and develop. The concern however still remains that a standalone module may trigger a complete review of the curricula and the consequent delay in achieving roll out for integration of the seismic component of the DAE.

The linkages to construction are somewhat more difficult (Kabir, 2008). The majority of students that were questioned as part of the Mission were doing a DAE (Civil) because it was one of the courses seen as having superior employment possibilities. In one way this is encouraging as it suggests that demand outweighs supply but it also mean that few understand what it is that Associate Engineers do. Students were asked how they knew about the engineering and whether they had any family connection that provided them insight. Only a few were in this category and it was clear that economics were the driving factor for the students and the issue for them is that engineering courses quickly become text book and loose the connection to "real life". Teachers struggle with this as many do not have the engineering experiences to connect back to real engineering situations. In such cases, an experienced engineer with insight can "inspire" and it is at this fundamental point where the linkage to industry is required. Different workshops can be organised through organisations such as PEC with guest speakers outlining the constraints under which they worked to resolve (rather than solve) some engineering issue. The value of this is that student start to realise that engineering is about applying principles and that there is a significant if not final social solution that needs to be addressed. This will be the case for Associate Engineers despite the view expressed in objective 1 that they should simply administer the drawings. Buildings are never built exactly to the drawings and there is a need to discuss and resolve across several trades. But what is important is that these linkages are not solely an issue for any proposed seismic module but applied across the DAE (Civil) curriculum. It also appeared that outside visits and field trips were not part of the teaching, if practiced, are potentially another industry linkage.

In addition, the use of design competitions at a local and national level does not appear to be common in Pakistan. This is an area where industry can again play a significant role in both setting up and judging such competitions. The benefits for the students are wide spread from developing presentation skills, team work and research skills whether they win or loose. Industry can also offer awards for the best student or best thesis or by initiating community projects that students work together on. These are all well known ways in which linkages to industry have been formed elsewhere and are potential models for use in Pakistan. However, the issue is not how they should be set up for the seismic module but how they should be instigated across the complete DAE curricula.

The security situation in Peshawar at the time of this Mission made it impractical to set up additional meetings and explore the strategies for specific development of linkages between the construction industry and GCT Peshawar as a test model. Moreover, the practical application of a test model is questioned by this report. However, the meeting with the All Pakistan Contractors Association did suggest that linkages are feasible and could be along the lines discussed above.

4.2.3 Training

The proposal from the beginning was to trial the module at GCT Peshawar and iron out any issues before any national roll out. However, such an approach has several concerns that include the following:

- a. The material would not be examinable,
- b. The material could not form part of the student's assessment,
- c. Teaching aids and resources would not be fully available, and
- d. One on one teacher training would have to be provided which would not be representative of the remainder of the Technical Institutes.

For this reason, it is suggested that the idea of a trial of the seismic module at GCT Peshawar be set aside in favour of a national roll out.

Finally, the training issues raised during discussion on DAE (Civil) curricula is discussed in the later Action plan.

5. DEVELOPMENT OF THE SEISMIC CURRICULUM

It was evident early on, that some provisional idea of the seismic course content would be beneficial and in response the proposed course content in figure 2 below was constructed. This was based on the author's experience in both an academic and humanitarian situations and "Seismic Design for Architects" by Andrew Charleson (Charleson, 2007). The book's non-mathematical and visual approach makes it ideal for Associate Engineers as well as Architects and moreover, it is set out as a course text book with increasing complexity with each successive chapter.

As touched upon earlier, the curriculum for the B.Tech. degree is outside the scope of this report. Nonetheless, an idea of its extent is necessary to ensure a "seamless staircase" career path between the two qualifications. This link can be forgotten but it was evident from student feed back in particular that such a link was necessary and hence, the inclusion of the B.Tech. in figure 2.

The course descriptions/content and learning objectives for each of these courses are tabulated in Appendix C. The learning outcomes have been left out at this stage and would be developed once the course content was accepted.

The proposed curriculum starts in year 2 with of the DAE with "Earthquakes and Ground Shaking" which outlines where and how seismic forces are generated. It then moves on to "How Buildings Resist Earthquakes" and discusses how buildings at the same site will modify and respond differently to the same ground shaking. Then in year 3 this will be followed up with "Seismic Design Approaches" which is not about how to apply the code but the rationale behind the approach in the code. For example, it would define and discuss the notion of "ductility" and its importance in seismic design. Different codes interpret this in different ways and the approach would be for Associate Engineers to understand the

reasoning and background to the detailing and construction they would be inspecting. The course would then look at the “Vertical Structure” and in particular the detailing for timber, steel and concrete vertical resisting systems. Finally the “Horizontal Structure” and the role of diaphragms, ties and struts to transfer seismic induced loads to the vertical resisting elements.

At that time it was assumed that contact hours meant actual contact hours and moreover were the total contact hours. Thus, the 6 hours theoretical and the 2 hours practical listed were viewed as actual contact hours. These were later reviewed up and modified to the Pakistani system where 1 hour of theoretical contact means 50 minutes actual contact and 1 hour practical contact equates to 3 periods of 40 minutes of actual contact.

The DAE course would be repeated in the first year of the B. Tech. for direct entrants. This would be followed by a seismic perspective on “Foundations” in the 2nd year. The 3rd year of the B.Tech. would include courses on “Vertical and Horizontal Configuration”, emphasizing the need to carefully place such elements in buildings, and two other courses on “Non Structural” subjects to complete the proposed seismic curriculum. This last course is critical because non-structural damage to items such as lighting, doors, electrical and mechanical services has over shadowed other building damage costs in past earthquakes to the point that it is not economical to repair the building despite the structure being repairable.

In the last year would be courses on “Retrofitting” how to strengthen earthquake risk buildings, “Professional Communication” how to communicate seismic requirements to and through other members of a design team and finally “New Technologies”.

This proposed curriculum greatly assisted Q&A during the meetings of objective 1 and grounded questions in a specific rather than a vague context. Moreover, there appeared to be good support for this proposed seismic curriculum during discussions with stakeholders, with 3 “wish list” areas for inclusion that were as follows:

- a. Disaster risk reduction (DRR) related to earthquakes and would include retrofitting of existing buildings,
- b. Special seismic issues for Pakistan such as the quality of reinforcing steel, quality control and the construction of rural housing. and
- c. Earthquake assessment procedures for existing and potentially post disaster buildings.

These were then included into proposed (version 1) of the seismic curriculum and after several alterations produced version 5 (refer to figure 3 below) which was the final version. The reason for showing these versions is to demonstrate the development of the curriculum and the rationale behind its construction.

Figure 2: Version 1 of the Proposed Course Content for the DAE (Civil)

DAE (CIVIL)			B. TECH (CIVIL)			
YEAR			YEAR			
1	2	3	1	2	3	4
	1. Earthquakes and Ground Shaking 2. How Buildings Resist Earthquakes	1. Seismic Design 2. Vertical Structure 3. Horizontal Structure	1. DAE COURSE	1. Foundations	1. Vertical Configuration 2. Horizontal Configuration 3. Non Structural- Causing Structural Damage 4. Non Structural- Not causing Structural Damage	1. Retrofitting 2. Professional Communications 3. New Technologies
	T 6 P 2	T 6 P 2				

The changes to produce version 5 were as follows:

- a. The topics in year 4 of the B.Tech were moved to year 3 and year 3 was combined with year 2.
- b. A new seismic research project (that could be on DRR, special issues in Pakistan or earthquake assessment) was introduced in the year 4 of the B.Tech.
- c. The theoretical and practical hours were reviewed and altered to follow the Pakistani system.
- d. Timber, steel and concrete were expanded to include masonry with the following amendment to the course descriptions (in Appendix C): “Masonry buildings that include brick, rock, mud brick and adobe that are perhaps more relevant to a rural environment will also be covered with a special interest in the appropriate detailing to achieve a suitable level of seismic resistance. Where appropriate relevant parts of the Building Code of Pakistan will be referenced.”
- e. GCT Peshawar confirmed that the integration should start at year 2 rather than pushing into year 1. They felt that year 1 was quite tight and that it was better positioned in years 2 and 3. They also suggested that the seismic content be integrated into Construction-II in year 2 and Concrete Technology and RCC Design in year 3. These two points of integration into the present DAE (Civil) curriculum require further verification and trial and have not been tested for being appropriate and feasible.
- f. Finally, it should be underlined that the additional contact hours for the seismic component represent only a 3% increase in theoretical content and a negligible 0.4% increase in the practical content. This is a minor change of the present course content.

This produced the final version of the course content for the integration of seismic design and construction into the DAE (Civil), given in figure 3 below.

Figure 3: Version 5 of the Proposed Course Content for the DAE (Civil)

DAE (CIVIL)			B. TECH (CIVIL)			
YEAR			YEAR			
1	2	3	1	2	3	4
	1. Earthquakes and Ground Shaking 2. How Buildings Resist Earthquakes	1. Seismic Design 2. Vertical Structure 3. Horizontal Structure	1. DAE COURSE	1. Vertical Configuration 2. Horizontal Configuration 3. Non Structural- Causing Structural Damage 4. Non Structural- Not causing Structural Damage 5. Foundations	1. Retrofitting 2. Professional Communications 3. New Technologies	1. Seismic Project covering (DRR, Seismic Assessment, Special Issue for Pakistan)
	T 0.4 P 0.1	T 0.4 P 0.1				

6. ACTION PLAN

From this material has emerged the following Action Plan. It covers several important areas with one key area.

6.1 The Key to the Action Plan

The key to any Action Plan for the integration of seismic design and construction into the DAE (Civil) must be the early acceptance of the suggested curriculum by NAVTEC. This acceptance would:

- a. Facilitate the immediate incorporation of the seismic design curriculum into the DAE (Civil).
- b. Up skill DAE (Civil) graduates in areas that are presently not in the curricula.
- c. Inject trained Associate Engineers into areas of construction that are presently vulnerable to seismic events and thereby raise awareness and the ability to create more appropriate responses.
- d. Provide a based load of Associate Engineers for future disaster responses that has not previously been possible.
- e. Set in action one part of a holistic solution to the vulnerability of people living in rural locations.

The following considerations add to the practicability of the proposed Action Plan:

- a. The changes suggested to the curricula are minor and have been checked by overseas experts and by the Head Earthquake Research Centre at UET Peshawar.

- b. The suggested seismic changes to the curriculum would be reviewed should a full curricula review of the DAE (Civil) course be instigated. Hence the suggested integration is not irreversible.

Thus, it is important that the above be discussed within NAVTEC so that an early instruction can be issued to Education Boards to proceed with the suggested seismic curriculum in this report.

6.2 Integration Strategies

There are two distinct integration processes that are as follows:

- a. Break the seismic course content into components that are slotted into courses of the existing curriculum, and
- b. Include the seismic module as a separate stand alone module into the present DAE (Civil) curriculum.

This report suggests adoption of the first option for the main stream DAE (Civil) students for reasons discussed earlier. This was not a clear cut decision and the 2nd option could be just as easily achieved with a similar approval and notification by NAVTEC.

However, to catch DAE (Civil) students in year 3 at the time of inclusion of the seismic curriculum would mean the inclusion of the year 2 seismic material as well into the year 3 DAE (Civil) curriculum for just that one batch. This would mean modest course content increases of 6% theoretical and 0.8% practical for that one year but would ensure that their DAE (Civil) qualification was current.

For those DAE (Civil) students that have already passed out, there should be the provision of a standalone module to make their DAE (Civil) current. Exactly how this will be done is not clear at this point but could involve continuing professional development (CPD) through either NAVTEC or the Pakistan Engineering Council (PEC). This could be launched immediately with the backup of the text books and teacher training mentioned earlier. Both organizations appear keen to be the representative professional body for Technicians and/or Associate Engineers with PEC having the ability to offer international recognition through its links with other Engineering Institutions under the Washington Accord.

Thus, this report suggests that the seismic module be integrated into the existing curriculum for the DAE (Civil).

6.3 Teacher Training

The training materials, venue and program need to be developed. But it is clear that the Earthquake Centre at UET Peshawar would be the obvious focal point for such training and that the text books and resources suggested in the Action plan would be the basis for any training. The method would be to take teachers through the material, the lesson plans and practical sessions contained within the teacher's manual. Training would also need to be provided on the detailing guide and how these could be used with students and what they

physically represent. Many teachers do not have industry background and such detailing will be foreign.

This training would be provided to 1 teacher from each accredited institution who would on completion of their training then train those within their respective institutions. It is assumed that this training would be provided to Government Institutions and that private institutions would make their own arrangements. Names of institutions and staff for such training should be initiated. The training would be over 4 days and could presumably be based at GCT Peshawar with time at the Earthquake Centre at UET Peshawar as required. Such details have not been discussed but seem to be the most likely at this stage.

6.4 Text Books

There is the need for the following texts which should start immediately:

- a. **A Teacher's Manual:** This would be as a textbook (though more compact) specifically designed for this seismic module. The text would cover the background of the course and expand on what would be presented in class by giving case studies and in depth reading. It could also be expanded to cover the B.Tech. course so that DAE students would be able to access more advanced material if required in the field.
- b. **Lesson Plan:** Power point presentations of the theoretical material that teachers could use as power points or use as dot points for white boards or chalk boards. Lesson plans for the practical content should also be included that would cover simple experiments to high light the theoretical material. For example, the use of 2D paper representations of buildings to show the different seismic responses of buildings to shaking and role plays showing the role of stiffness in seismic response of building elements are easily and intuitively understood by students.
- c. **Detailing Guide:** this guide should consist of engineering drawings of the relevant details for timber, steel and concrete structures as well as brick, rock, mud brick and adobe house construction. These should be in an engineering drawing format rather than photographs. It is important that students get accustomed to the language of engineering which is still substantially as 2D paper drawings.
- d. **Resources:** training should also include practical lessons on the use of any of the resources suggested later. This potentially includes soil testing, concrete testing and a computer software program.

The cost for this training has been estimated at around \$250-\$300US/per person to cover training costs, travel and accommodation but not training materials.

6.5 Resources

Funding would need to be provided for the purchase of the following equipment (one for each institution) that is seen as complementing the proposed seismic module.

Scala penetrometers are suggested for soil investigations. These are rugged portable hand operated test rigs for ascertaining the bearing capacity of building sites. Many seismic schemes do not incorporate nor allow for the influence of the soil conditions found on site

because of the difficulties of organizing such testing. This is overcome by the use of such equipment which because of its rugged construction and portability means that Associate Engineers could do such testing themselves in remote and difficult to access locations. In addition, such equipment would also support other soil and foundation material outside of the seismic module but still within the DAE (Civil) curriculum.

Rebound hammers have also been specified because of the difficulty in achieving suitable concrete strengths on site. Where concrete is provided by a larger scale batching plant such tests should be verification. However, where this is not the case and concrete is mixed on site then such testing can by default become more critical and almost essential for the quality control of the specified concrete strengths. This is not a desirable situation but is often the reality in provincial and certainly rural locations. In many rural situations concrete may be substituted by masonry. Here, rebound hammers with some ingenuity can also be applied and relationships developed for the strength of bricks, stone and other masonry building blocks. Again, as with the scala, rebound hammers can also be used outside the seismic module for other areas of the DAE (Civil) curriculum such as concrete design and concrete technology and testing. Thus, both sets of equipment have several potential applications within the DAE.

Finally, it is suggested that the RESIST computer program be altered to reflect the lateral load (wind and seismic) codes for Pakistan. The program is an intuitive straight forward checking program that in real time can check whether a proposed structural system is code compliant and if not then simple changes such as the length of a shear wall can be inputted till an adequate structure is achieved. It can also compare alternatives but its huge advantage over data hungry programmes such as structure analysis programme (SAP) is its speed ease of use. For example to set up a 4 storey concrete frame building with 3 bays in the X and Y direction would take an experienced SAP user around 3-4 hours to set up. In RESIST this would take around 10 minutes for a novice user of the programme. There are certainly modelling restrictions for RESIST compared to SAP but RESIST has significant and obvious teaching gains over SAP. The cost for the program is indicative but would be a onetime cost with copies being presumably freely available to government institutions.

The costs for these resources would be as follows

- | | |
|--|----------------------|
| a. Purchase of scala penetrometer | Approx. \$100US each |
| b. Purchase of a rebound hammer | Approx. \$125US each |
| c. Adaptation of the RESIST Software Program to Pakistan codes | Approx. \$35,000US. |

It is assumed that there are sources of funding either through the One UN, Government or private donations for the purchase of such resources.

6.6 Timelines

Timelines were constructed to review the program for the suggested action plan.

The Pakistan academic year runs from September to June with a 3 month summer vacation and a two week winter vacation. In the Northern Areas, parts of Pakistan Administered State of Jammu and Kashmir and parts of Balochistan this is reversed and there is a two month

winter holiday and a two week summer vacation. Snow and the cold temperatures in these elevated areas means that schools are closed. Thus, any overall timeline should be fitted to a September start date which would mean a 6 month program if it were to start in 2009 or an 18 month program if it were to start in 2010.

The first timeline in table 1 below is based on a linear approach where each successive parts of the action plan follows on from the one before. The times for each input have been calculated on the following basis:

- a. **NAVTEC Adoption**: Estimates based on the understanding from the meetings and the final presentation and the assumption that the adoption of the proposed curricula changes can be actioned by letter from NAVTEC to the provincial Boards of Technical Education.
- b. **Integration Process**: Estimate based on meetings with GCT Peshawar and discussions with the concerned authorities in both Lahore and Peshawar.
- c. **Training Process**: This time was base on a 3-4 day residential course (which was taken as one calendar week) for 20 lecturers, one from each of the affiliated institutions providing a DAE (Civil) course. There were no confirmed total numbers for these institutes at the time of writing this report but the educational authorities in Peshawar reported 16 Government and 32 Private Institutions in the NWFP Province and similar 32 and 85 for the Punjab province and hence a total of 40 Government and 117 Private Institutions offering a DAE (Civil) in their jurisdiction. If these are pro rata on the basis of population then there could be expected to be 60 Government and 170 Private Institutions for all of Pakistan. Hence for a class numbers of 20 this would represent 3 weeks for the Government and 8 weeks for the Private Institutions, a total of 11 weeks or say 3 months.
- d. **Text Books**: Estimate based on a manual rather than a textbook, a details manual and power point lesson plans.
- e. **Resources**: These would need to be imported and a time allowance is include in the timelines below based on previous experiences in other countries such as Indonesia, India, Brunei and Australia. This timing is not a critical aspect of the timelines below.

Based on this, Timeline 1 (in table 1) suggests that the overall integration process of the seismic curriculum as outlined in this Action Plan is of the order of 10 months. This is encouraging as it means that a roll out date for the seismic curriculum for September 2010 is feasible.

Following on from this, timelines 2 and 3 consider whether it would be feasible to have the seismic module ready for roll out in September 2009 rather than 2010? The advantage is that the 2009 cohort would benefit from the inclusion of the seismic module and that Associate Engineers with a seismic background would be in the market one year earlier. The down side is whether necessary preparation can be in place?

Time line 2 shifts the Integration process forward and starts immediately. The remaining processes are shifted forwarded but are held at the Adoption point. Thus training and textbooks would start concurrently with resources coming in at the end of the program. This

would give a 6 month program and hence a roll out in September 2009 is theoretically feasible. Furthermore, if the Textbook Process were pulled forward then the program would come in under 6 months.

Hence, it is feasible to achieve a roll out of the seismic curriculum for the DAE (Civil) for the start of the year in September 2009. Whether this is warranted or desirable would need to be confirmed by NAVTEC who hold the key to the Action Plan in terms of acceptance of the proposed seismic curriculum. However, funding arrangements would also need to be secured and it would seem more realistic to work to a roll out date of September 2010 rather than 2009.

Table 1: Timelines for Different Approaches

Timeline Number	Timeline															
	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1. A linear approach with each part of the Action plan following ton from the one before. Note the resources could be procured earlier.	NAVTEC Adoption	█	█													
	Integration Process			█	█											
	Training Process					█	█	█								
	Text book Process							█	█	█	█					
	Resources								█	█	█					
2. Can it be done in less than 6 months? This approach overlaps some of the Action plan processes.	NAVTEC Adoption	█	█													
	Integration Process	█	█													
	Training Process			█	█	█										
	Text book Process			█	█	█	█									
	Resources				█	█	█									

3. Can it be done in less than 6 months? This approach further overlaps the Action plan processes.	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	NAVTEC Adoption														
	Integration Process														
	Training Process														
	Text book Process														
	Resources														

6.7 Gender

The DAE (Civil) appears to be all male students as discussed earlier. In the areas covered for this report there were no institutions that could be named that offered this course to female students? Nonetheless, gender equality and the realization of the MDG's remain on the agenda for education in Pakistan (MoE, 2005). It is suggested that the seismic module developed in this report be also included in the DAE (Architecture) as an upgrade of its present seismic component. The visual non mathematical nature of the suggested seismic module would sit as comfortable in DAE (Architecture) as it would in the DAE (Civil) and would mean that female students would have similar assess and opportunity.

7. CONCLUSIONS

The lessons learnt from this work and the issues faced are similar to many other countries. For example, the rural impact of the Sichuan Earthquake in China is identical to what occurred in Pakistan. In addition, the reconstruction and associated seismic design and detailing issues in Banda Aceh, Indonesia following the Asian Tsunami challenged the concept of “Build Back Better”. In both situations the training and role of technicians in the post disaster seismic response and disaster risk reduction particularly for the poor was not fully appreciated. Consequently, it will be important for UNESCO to track this initiative.

Two keys for the timely integration of seismic design and construction into the DAE (Civil) programme are the speedy adoption of the suggested curricula by NAVTEC and funding. Presumably, if funding were readily available then this would assist NAVTEC in their decision making.

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Persons Met During The Mission

A. National Vocational and Technical Education Commission.

1. Mr. Athar Tahir, Executive Director.
2. Mr. Muhammad Riaz, Director General (Planning).
3. Dr. Hazrat Hussain, Director (Skill Standards and Curricula).

B. Polytechnic Institute for Women, Islamabad.

4. Mrs. Farida Javaid, Principal.
5. Mrs. Tehmina Bukhari, Head Architecture Department.

C. National Institute of Science and Technical Education, Ministry of Education, Islamabad.

6. Dr. Farid Akhtar Khawaja, Director General.
7. Mr. Zahid Ali, Associate Professor (Civil)/Deputy Director General (Technical).

D. Pakistan National Commission for UNESCO, Ministry of Education, Islamabad.

8. Mr. Saqib Aleem, Secretary General.

E. UNHABITAT, Islamabad.

9. Ms. Maggie Stephenson, Technical Advisor.
10. Mr. Ehsan Sheikh, Regional Technical Expert.
11. Mr. Babar Tanwir, Research Engineer.
12. Mr. Hameed Mumtaz, Regional Technical Expert

F. Earthquake Reconstruction and Rehabilitation Authority (ERRA), Islamabad.

13. Mr. Waqas Hanif, Programme Manager Rural Housing.

G. National Engineering Services Pakistan (Pvt) Limited, Islamabad (NESPAK).

14. Mr. Rana Khalid Hameed, Vice President.
15. Mr. Imran Taj, Chief Architect.
16. Mr. Abid Mahmood, Chief Architect.

H. Pakistan Engineering Council, Islamabad.

17. Dr. Ashfaq Ahmed Sheikh, Deputy Registrar.

J. NWFP Board of Technical Education, Peshawar.

18. Eng. Abdul Ghaffar, Chairman.
19. Mr. Zulfiqar Hussain Durrani, Assistant Secretary (Curriculum).

K. Government College of Technology Kohat Road Peshawar.

20. Eng. Sartaj Gul, Principal.
21. Eng Muhammad Ullah, Associate Professor (Civil Technology) / Vice Principal.
22. Eng. Noor Badshah, Associate Professor (Civil Technology).
23. Eng. Muhammad Idrees, Head Civil Technology Department.
24. Eng. Aleem John, Assistant Professor (Civil Technology).
25. Eng. Abdul Rasheed, Assistant Professor (Civil Technology).
26. Eng. Rizwan Ullah, Lecturer Civil Technology.
27. Eng. Khurshid Ali, Lecturer (Civil Technology).
28. Eng. Sami Ullah Jan, Lecturer (Civil Technology).
29. Students DAE (Civil) 3rd Year (32 in number).

L. Earthquake Engineering Centre, Deptt. of Civil Engg. NWFP UET, Peshawar.

30. Eng Dr. Qaiser Ali, Head Earthquake Engineering Centre.

M. Punjab Technical Education and Vocational Training Authority, Lahore.

31. Ms. Rafia Nazir, Secretary.
32. Professor Javed Iqbal Malik, General Manager (Academics).
33. Ms. Samia Javed, Deputy Manager (Arch).
34. Eng. Syed Kashif Ali, Deputy Manager (Tech).
35. Eng. Azhar Iqbal Shad, Principal Govt. College of Technology Sahiwal.
36. Eng. Mazher Abbas Naqvi, Principal G.C.T. Rasul distt. Mandi Bahauddin.
37. Eng. Syed Shair Ali, Principal G.C.T. Raiwind Road Campus, Lahore.
38. Architect Abdul Jabbar, Incharge Architecture Deptt. G.C.T. Railway Rd. Capmpus Lahore.

N. Punjab Board of Technical Education, Lahore.

39. Professor Muhammad Tariq, Chairman.
40. Mr. Muhammad Ismail, Research Officer.
41. Ms. Meher-Un-Nisa, Manager Trade Testing Board.

O. Government College of Technology Raiwing Road Campus Lahore.

42. Eng. Syed Shair Ali, Principal.
43. Eng. Mustaasam Bashir, Chief Instructor (Civil Technology).
44. Eng. Nadeem Zaigham, Senior Instructor (Civil Technology).
45. Eng. Sheikh Muhammad Afzal, Senior Instructor (Civil Technology).
46. Eng. Muhammad Iqbal, Senior Instructor (Civil Technology).
47. Students 3rd Year DAE Civil Technology (15 in number).

P. All Pakistan Contractors Association, Lahore.

48. Mr. Muhammad Yunus Khan, Secretary.
49. Eng. Zafar Ullah Khan, Chief Executive Zee Khan Associates (Pvt) Ltd. 38-A-II Gulberg-III, Lahore.

50. Mr. Hammad Akbar Khan, Resident Director Husnain Group of Companies, Phase IV, DHA Lahore.
51. Mr. Arshad Majeed Bhatti, Izhar Construction (Pvt) Ltd. 35-Tipu Blk, New Garden Town, Lahore.
52. Eng. Z. Alamgir, Izhar (Pvt) Ltd. Lahore.
53. Eng. Ahmad Jawad, Izhar (Pvt) Ltd. Lahore.
54. Raja M. Iftikhar, Izhar (Pvt) Ltd. Lahore

Q. NAVTEC and UNHABITAT Officials attending Meetings at Peshawar & Lahore.

55. Mr. Muhammad Israr, Monitoring and Evaluation Officer, Regional Office NAVTEC Peshawar.
56. Mr. Muhammad Usman, Deputy Director, Regional Office NAVTEC, Lahore.
57. Mr. Shahidullah Wazir, Technical Expert, UNHABITAT Regional Office Peshawar.

**DAE (CIVIL)
SCHEME OF STUDIES**

FIRST YEAR

			T	P	C
Gen	111	Islamiat & Pak Studies	1	0	1
Eng	112	English	2	0	2
Math	113	Applied Mathematics-I	3	0	3
Ch	112	Applied Chemistry	1	3	2
Phy	122	Applied Physics	1	3	2
Shop	162	Workshop Practice	0	6	2
CT	114	Surveying-I	2	6	4
CT	123	Construction-I	2	3	3
CT	133	Civil Drafting-I	1	6	3
T o t a l			13	27	22

SECOND YEAR

Gen	211	Islamiat/Pak Studies	1	1	0	
Math	212	Applied Mathematics-II	2	0	2	
Comp	122	Computer Applications	1	3	2	
CT	212	Public Health Engineering-I	1	3	2	
CT	224	Surveying-II	2	6	4	
CT	233	Construction-II	2	3	3	
CT	243	Civil Drafting-II	1	6	3	
CT	253	Mechanics of Structures	2	3	3	
CT	262	Quantity Surveying-I		1	3	110
T o t a l			13	27	22	

THIRD YEAR

Gen	311	Islamiat & Pak Studies	1	0	1
CT	312	Project Management	2	0	2
CT	322	Quantity Surveying-II	0	6	2
CT	333	Public Health Engineering-II	2	3	3
CT	344	Hydraulics & Irrigation	3	3	4
CT	353	Railways, Docks, Harbors and Bridges	2	3	3
CT	364	Concrete Technology and RCC Design	3	3	4
CT	373	Soil Mechanics, Highways and Airports	2	3	3
CT	381	Civil Engineering Project	0	3	1
T o t a l			15	24	23

DESCRIPTIONS OF COURSE AREAS AND LEARNING OBJECTIVES FOR THE DAE (CIVIL).

Listed below are the contents for each of the proposed seismic teaching areas for the DAE (Civil). These have in part been adapted from book “Seismic Design for Architects” by Andrew Charleson.

<p>Earthquakes and Ground Shaking</p>	<p>Learning objectives. To appreciate that:</p> <ol style="list-style-type: none"> 1) Ground shaking for the same earthquake is felt differently at different locations 2) Ground shaking has a pattern of different motions 3) Ground conditions can magnify the original earthquake accelerations. <p>Significance of earthquakes world wide and in Pakistan Tectonic plates, old myths about how earthquakes occur, types and timing of ground waves, community vulnerability and the notion that earthquakes don't kill but buildings do, are all affected equally by earthquakes, why earthquakes occur, when and where earthquakes strike, earthquake magnitude and intensity, the nature of earthquake shaking, characteristics of ground shaking, importance of ground conditions.</p>
<p>How Buildings Resist Earthquakes</p>	<p>Learning objectives. To appreciate that:</p> <ol style="list-style-type: none"> 1) Although ground shaking is the same at any one location the seismic loading resisted by the building is not. 2) Seismic loads are generated by mass and hence any mass will generate seismic loads. 3) Such loads require force paths and if not provided will take the most direct path to the ground. 4) Resisting earthquakes is not a matter of making buildings strong enough as ductile. <p>Nature of seismic forces, the difference between seismic and wind loads, $f = ma$, factors affecting the building's seismic response (such as building weight, natural period, damping, response spectrum, ductility), resisting seismic forces (issues of strength, stiffness and torsion), force paths.</p>
<p>Seismic Design Approaches</p>	<p>Learning objectives. To appreciate that:</p> <ol style="list-style-type: none"> 1) The importance of ductility and the need to select the best conceptual design approach for the building. 2) Having determined the overall conceptual approach to design members to ensure that this occurs 3) The different levels of design (life safety first and then increasing levels of building damage) <p>Historical overview for Pakistan and overseas, capacity design, current seismic design philosophy, levels of earthquake design, ductility, and areas of special detailing.</p> <p>Where appropriate relevant parts of the Building Code of Pakistan will be referenced.</p>
<p>Horizontal Structure</p>	<p>Learning objectives. To appreciate that:</p>

	<ol style="list-style-type: none"> 1) Although the focus is often on vertical resisting elements, horizontal force transfer systems are just as important. 2) Beams and floors can do the two jobs of carrying vertical gravity loads and transferring horizontal seismic loads. <p>Explain the need for horizontal structure to transfer seismic loads, diaphragms, diaphragm materiality and type, diaphragm penetrations, transfer diaphragms, bond beams, collectors and ties. This would include the typology and particularly detailing for timber, steel and concrete structures. Masonry buildings that include brick, rock, mud brick and adobe that are perhaps more relevant to a rural environment will also be covered with a special interest in the appropriate detailing to achieve a suitable level of seismic resistance.</p> <p>Where appropriate relevant parts of the Building Code of Pakistan will be referenced.</p>
Vertical Structure	<p>Learning objectives.</p> <p>To appreciate that:</p> <ol style="list-style-type: none"> 1) Although there are relatively few vertical types of structures there are numerous combinations of type, materials and ductility. 2) These systems have differing advantages and disadvantages. <p>Different types of vertical structure (commonly shear walls, braced frames, moment frames), shear walls (structural requirements, materiality and height including confined masonry walls, ductility, coupled walls), braced frames (types such as K, cross bracing, V, inverted V diagonal and eccentrically braced, structural requirements, materials, ductility), moment frames (types, structural requirements, material and heights of frames, ductility) mixed systems. This would include the typology and particularly detailing for timber, steel and concrete structures. Again, masonry buildings will also be covered with a special interest in the appropriate detailing to achieve a suitable level of seismic resistance.</p> <p>Where appropriate relevant parts of the Building Code of Pakistan will be referenced.</p>
Foundations	<p>Learning objectives.</p> <p>To appreciate that:</p> <ol style="list-style-type: none"> 1) Foundation design and construction needs a team approach.. 2) Foundations transfer earthquake loads to buildings 3) Review testing and particularly the use of a scala penetrometer. <p>Seismic foundation problems and solutions (liquefaction, subsidence, landslides, foundation failure), foundation types, foundation investigations, retaining structures (retaining walls, basements, underground structures). This would include foundation testing using scala penetrometers.</p>
Horizontal Configuration	<p>Learning objectives.</p> <ol style="list-style-type: none"> 1) Early topics looked at the horizontal and vertical structural systems that could be used and this topic reviews the placement of those structures inside a building. 2) Earthquakes produce directionally random shaking which requires vertical structure in each of the two orthogonal axes of a building 3) Configuration in both plan and elevation are required. 4) Configuration (both horizontally and vertically) will significantly enhance a building's seismic performance.

	Torsion, re-entrant corners, diaphragm discontinuities, non parallel systems, pounding and separation, bridging between buildings.
Vertical Configuration	<p>Learning objectives.</p> <p>To appreciate that:</p> <ol style="list-style-type: none"> 1) Many of these issues will result in building collapse if they are not addressed. And are therefore critical. <p>Soft storeys, short columns, discontinuous and off set walls, set backs, buildings on sloping sites.</p>
Non Structural Elements: Causing Structural Damage.	<p>Learning objectives.</p> <p>To appreciate that:</p> <ol style="list-style-type: none"> 1) Non structural elements are usually those elements that make the building habitable and are not intended to resist seismic loads. 2) Non structural elements form a major part of the cost of a building (20-30% for industrial ware housing to 85+% for more intensive use buildings). 3) Non structural elements can represent a significant hazard to building occupants in an earthquake. 4) Non structural elements have the potential to significantly damage the primary seismic resisting system <p>Infill walls (problems and solutions), staircases</p>
Non Structural Elements: Not causing Structural Damage.	<p>Learning objectives.</p> <p>To appreciate:</p> <ol style="list-style-type: none"> 1) The importance of the seismic performance of non structural elements that do not cause structural damage but are important in terms of overall cost and functioning of a building. <p>Cladding (masonry, panels, other materials, windows and curtain walls), parapets and appendages, partition walls, suspended ceilings and raised floors, mechanical and electrical equipment, building contents.</p>
Retrofitting	<p>Learning objectives.</p> <p>To appreciate:</p> <ol style="list-style-type: none"> 1) That retrofitting is intended to reduce the vulnerability to the building's occupants and the building itself to seismic damage. 2) That retrofitting is appropriate for any scale of building whether it be an earth mud house or a high rise building. 3) The significance of historical buildings <p>Why retrofit, identifying buildings that need to be retrofitted, assessment, retrofit objectives, retrofit approaches (improving seismic performance, provision of new structural systems, weight reduction, adjacent buildings) retrofit techniques (un-reinforced brick walls, diaphragms, shear walls, braced frames, moment frames) non structural retrofit (masonry infill walls, staircases other hazardous elements), historic buildings.</p>
Professional Collaboration and Communication	<p>Learning objectives.</p> <p>To understand:</p> <ol style="list-style-type: none"> 1) The expectations of key stake holders and the justification for seismic provisions in buildings with particular reference to the contractors and trades people on site. <p>What makes seismic design different, the client, the design team, the contractor, post earthquake, community involvement and participation, community design.</p>

New Technologies	<p>Learning objectives.</p> <p>To appreciate that:</p> <ol style="list-style-type: none"> 1) Seismic design and construction is a relatively youthful discipline. 2) Though it does not experience the rapid change that other disciplines are subject to there are new technologies that are being developed. <p>Seismic isolation, dampers, damage avoidance, innovative structural configurations, structural design approaches, other developments.</p>
Special Issues for Pakistan	<p>Learning objectives.</p> <p>To appreciate that:</p> <ol style="list-style-type: none"> 1) There are several seismically related issues that Pakistan faces that are both similar and different to other countries. 2) While the technical requirements outline here are important they are often over ridden by social and building cultural concerns. <p>Rapid urbanization, regulatory controls and code standards, design issues, construction issues, resources.</p>
Disaster Risk Reduction	<p>Learning objectives.</p> <p>To understand that:</p> <ol style="list-style-type: none"> 1) Earthquakes are a significant disaster risk to Pakistan. and as such require appropriate planning. <p>Risk, vulnerability, hazard, who and where are the vulnerable, urban planning.</p>
Assessment of Earthquake Risk in Existing Buildings	<p>Learning objectives.</p> <p>To appreciate that:</p> <ol style="list-style-type: none"> 1) There is a need to asses both before and after an earthquake and learn the assessment techniques. <p>Pre earthquake assessment, post earthquake assessment.</p>