Training on Structural and Seismic Engineering Report 2017

C2C on Post-earthquake support on reconstruction
I. Summary of training on Structural and Seismic Engineering 2016

The first year of the Structural and Seismic Engineering Training explored various construction techniques in RC structures, steel frame structures and timber structures.

Through observation and direct feedback from participants, it became evident that the municipal engineers have sufficient technical knowledge and background in construction methods and design. It was identified that the biggest challenge was to narrow the capacity/knowledge gap between constituents among all stakeholders, especially the house owners, contractors and construction laborers. Furthermore, city engineers had limitations on spending enough time visiting construction sites to ensure the quality of construction and compliance to the Building Code.

Based on this result, the second year trainings focused on the inspection process and making improvements to the system to ensure effective quality control of construction.
II. Post-earthquake initiatives by Kathmandu Metropolitan City (KMC)

i. Installation of eBPS: e-Building Permit System

The Building Construction Permit Department of Kathmandu Metropolitan City has been working on the Electronic Building Permit System (EBPS) with the support of UNDP. This was implemented with the goal to speed up the building permit application system by digitalizing documents and allowing applications to be processed online.

E-BPS enables municipalities to manage a building permit system by integrating the NBC and municipal BBL. It supports municipal staff members to maintain a building permit database and ensure NBC and BBL compliance for individual buildings through an intuitive web interface.

Source: http://www.kmcebps.gov.np/

ii. 14 Changes in By-Laws

According to KMC, there have been 14 changes and additions (as of March 2017) made to the by-laws since the earthquake, including requirements for set-backs and external walls to ensure there is enough space for emergency vehicles and evacuation of people in times of disasters, additional construction to existing buildings and implementation of soil tests, among other topics.

iii. Restructuring to KMC Organisational Structure

Formerly under the Social Welfare Department as a division, the Disaster Management Department was officially established in 2016.

The new department is responsible for disaster risk reduction programs within KMC and monitoring the infrastructure development according to building by-laws and the National Building Code (NBC) in coordination with the Building Construction Permit Division.
### III. Overview of training on Structural and Seismic Engineering 2017

#### 4th Training, March 2017, Yokohama

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| - Knowledge sharing in awareness raising among house owners and laborers in safe construction and DRR  
- Knowledge sharing in construction management  
- Techniques in steel frame construction  
- Seismic resiliency in infrastructure | Engineers from Kathmandu and Yokohama shared their progress during the 21st CITYNET Japan Forum in addition to attending lessons shared by the experts from the Housing and Architecture Bureau of the City of Yokohama. | 1. Utilization of heritage buildings  
2. Yokohama’s measures against earthquakes and steel frame structures and site visit to steel frame manufacturing factory  
3. Quality management of public facility construction  
4. Site visit to seismic isolation device  
5. Awareness-raising activities in DRR (DRR Learning Center)  
6. Introduction and site visit to urban redevelopment project incorporating DRR measures  
7. Private sector initiatives in resilient houses – site visit to Nice Corporation |

#### 5th Training, July 2017, Kathmandu

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| - Understanding quality control and construction management in Nepal  
- Identification of points of improvement during construction and in inspection process | Knowledge sharing sessions were complemented with workshops where KMC engineers engaged in active discussions to propose possible solutions and recommendations. The workshop offered an opportunity for engineers from varying municipalities to share their experiences and ideas with each other. This particular training was also collaborated with the World Bank Nepal office. | 1. Essentials to constructing safe RC buildings in Japan  
2. Initiatives to improve building construction process  
3. Site visit to RC residential building construction site  
4. Policies on inspection and construction contracts  
5. Localising lessons from Japan for building back better- technical and management perspective  
6. Resilient urban planning and implementation: Case study from Dharan  
7. Designing a resilient city: community led initiatives  
8. Inspection process during construction  
9. Workshop on inspection process and group presentations |

#### 6th Training, November 2017, Kathmandu

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| - Identification of roles of KMC engineers in the improvement of inspection process and quality control in construction | Specific inspection points were discussed to identify tasks which may help improve construction quality and management. Experts from the academic and private sector in Nepal also shared their initiatives for improving overall construction management. | 1. Earthquake resistant building design and its application in construction  
2. Understanding and addressing the gap in resilient construction practices  
3. Differences between construction process in Nepal and Japan  
4. Site visit to construction site of 3 storey school building  
5. Feedback and observations of day 2 site visit  
6. Workshop 1 – Points to be aware of in reinforcement and concrete work  
7. Workshop 2 – Overall management setup for construction  
8. Workshop 3 – Administrative inspection system  
9. Potential remedies for improving construction practices at the supervising engineer’s level |
III. Overview of training on Structural and Seismic Engineering 2017

OUTPUTS

• Importance of public awareness raising activities in DRR shared
• Methods to increase resiliency in infrastructure shared
• Main topics of training narrowed down to awareness-raising, quality control of construction practices

OUTPUTS

• Important points which influence structural performance of the building were identified through walkthrough of the inspection process
• Participants learned initiatives to improve inspection process and quality control from different municipalities

OUTPUTS

• See next page for details
IV. Outputs of Workshops of 6th Training

Workshop 1: Points to be aware of in reinforcement and concrete work

A. Current issues
- Bending of reinforcement bars while transporting
- Poor quality of sand and cement
- Construction material stored/kept directly on open ground
- Price fluctuation of construction material

B. Recommendations
- Transport bars without bending or cut bent sections and only use straight portions
- Quality control mechanism and standard need to be practiced through government
- Provide clear awareness on consequences of incorrect storage to labors and provide appropriate location
- Price control mechanism and monitoring need to be practiced through government

Workshop 2: Overall management setup for construction work

A. Current issues in inspection and quality control
- Lack of understanding of building codes and by-laws permitted by municipality by house owners and contractors
- Lack of professionalism and ad-hoc management
- Lack of interaction and awareness coordination between the owner and the designer before the drawing is approved
- House owners are blamed for low quality construction

B. Recommendations
- Permission of engineer/architect is required if changes to plans are necessary
- All stakeholders (house owners, engineers/architects, contractors) need to approve of changes made during construction period
- Discuss and finalize design and drawing before beginning construction

Workshop 3: Administrative Inspection System

A. Current issues in inspection and quality control
- Lack of municipal engineers
- Lack of sufficient knowledge of inspector
- Construction by untrained masons
- No existing consequences nor laws to control contractor if construction is done incorrectly or not according to code

B. Recommendations
- Increase monitoring and inspection steps
- Government sets up system to give authority to city engineers/local authority to conduct inspection and give final permission
- Conduct training for masons and house owners before granting them building permission
- Create a penalty system for contractors who do not comply to code
- Set-up notice boards on site to inform house owners about construction materials

“Learned problems different municipalities are facing and probable solutions”
“I learned how to identify problems at construction site”
“We learned practical knowledge from group discussions”
“Group discussions helped increase my confidence level”
“Practical approach was useful in teaching site inspection methods”
V. Learnings from Site Visits to Construction Sites

This section introduces some improvement points to be made at construction sites suggested by representing architects and engineers from Yokohama City and various municipalities in Nepal.

i. Improvements in the production and casting of concrete

- Mixing the correct proportion of materials such as water, cement and gravel
- Improve quality of materials
- Appropriate storage of materials
- Correct method of concrete casting

A. The materials that make up the concrete mixture are often not measured. For example, the amount of water, one of the most important determinants of concrete, is simply poured into the mixture using a bucket that has no measuring scale. This also indicates that the strength and quality of concrete varies depending on the labourers, which is likely to compromise the strength of the building.

B. The size of gravel should be smaller than 20mm, however in most cases it exceeds the number indicated in the Code. The management of the quality of the material is a point that may be improved.

C. As seen in picture C, the floor surface inside the reinforcement bars is quite rough with potentially loose aggregate which may weaken the column joint. This needs to be compacted to result in a smoother surface as seen in D.

E. Seen in the photo are bags of cement stored at the construction site with no protection from the rain or other sources of moisture. In many cases the exposed cement absorbs rain or moisture from the ground and are found to have already hardened even before the bags have been opened. Simply covering the bags with a waterproof sheet and placing them on wooden planks would be effective.

F. A photo of the corner of a concrete pillar shows the result of the lack of compaction work. Gravel is exposed because the concrete liquid did not reach the corners of the mold. Although vibrators are used at construction sites, they are often not long enough to reach the bottom half of the pillars when inserted from the top. Side vibrators or simple hammering of the molds may solve this problem if labour workers have the knowledge.
ii. Improvements in the managing of RC bars and their installation

- Appropriate storage of materials
- Transportation of materials
- Position of cast

G. As seen in the photo, RC bars are bent. This happens due to restrictions during transportation of these construction materials. While these bars are being transported into Kathmandu from factories in the south of Nepal, they need to be bent as they are too long to pass through the narrow roads in the mountainous areas and small villages if they are kept straight. When these bent RC bars are brought to the construction site, they are straightened and then used. However, this process of bending and straightening of the bars weakens the bent area, ultimately effecting the overall strength of the structure. Ideally the bars should be transported without bending, however if this is not possible, it is recommended that the sections that were bent should be cut off and not be used.

H. The photo shows how RC bars are stored at construction sites in Japan. They are elevated from the ground using wooden blocks to avoid contact with moisture on the ground. When not in use, they are also covered with plastic sheets to avoid contact with rain water. Rust on the RC bars is also a major cause of decrease in the bars’ strength.

I. As seen in the picture, the correct setting would be to have the RC bars in the center of the beam with equal amount of concrete covering on both sides. This is also to prevent RC bars from external impacts including moisture.

iii. Improvements in Safety Management

J. Wearing sandals, short sleeve shirts and shorts, and not using helmet is common in Nepalese construction sites. Work boots/ shoes for construction sites and safety belts are essential to prevent serious injuries at a construction site. Although appropriate equipment and uniforms are required to be provided by employers, the protection of workers’ safety may not be the priority of all contractors. In addition, budget allocated for these may be spent on other matters. Employers need to take a conscious decision to protect the safety of their workers and act according to regulations.

K. The building under construction must be equipped with safety measures, such as nets to protect workers from falling and protect bystanders from falling objects. As seen in the photo, a safety net is on the top floor, however it can be further improved by adding similar nets to the floor below.

Yokohama experts recommended that records be kept of injuries and deaths related to construction in order to identify the causes to implement preventative measures. In Japan, of out of approximately 900 deaths in all industries, 270 deaths were reported to be at construction sites in 2016. This number has been reduced by 88% in comparison to 1973, with continued efforts to reduce risks posed to construction workers.
VI. Statistics

The second and third trainings in 2016 were attended by 14 municipalities and 24 and 32 engineers respectively. These municipalities were: Kathmandu, Lalitpur, Bhaktapur, Madhyapurthimi, Kirtipur, Kageshwori-Manohara, Shankharapur, Gokarneswor, Budhanilkantha, Tokha, Nagarjun, Chandragiri, Dakshinkali and Tarkeshwor. KMC invited other municipalities from within the valley which were affected by the earthquake, with hopes to support reconstruction efforts by other municipalities.

The 5th training in July 2017 saw an increase in participants and municipalities as the World Bank collaborated to bring engineers from outside the valley. The 10 new municipalities were Vyas, Triyuga, Siddarhanagar, Patalibazar, Ghorahi, Dharan, Dhangadhi, Damak, Butwal and Gorkha.

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VII. Recommendation and Way Forward

i. Challenge and Recommendations
The challenge since the first year of the Structural and Seismic Engineering Training project have been identified to be the narrowing of the knowledge gap between the house owners, contractors and experts in the construction industry.

Through workshops and meetings, municipality engineers have been discussing what they can do within their professional responsibilities and how they can work with each other and other stakeholders in order to bridge the gap. The newly established Disaster Management Department and the Building Construction Permit Department have been conducting numerous meetings to discuss initiatives to improve the building permit system and the quality of construction, and the roles they would need to play in order to achieve these.

During the workshops, participants suggested working with engineers at the district level to increase the number of inspections during construction, taking the lead in implementing awareness raising activities for residents to build safer buildings, conducting technical training sessions for house owners as a condition to receive building permits, among others.

ii. Direction for the last year of training and future
Building on the lessons shared through Yokohama and the feedback from the participants, the training contents for 2018 is expected to primarily include topics related to construction quality management and the inspection process. Through the remaining trainings, KMC expects to develop awareness raising material which include guidelines to construct a house geared towards non-technical people. This guideline will include simplified versions of the construction by-laws, the National Building Code and the reference for managing quality construction practices as well as the legal procedures involved in the building construction permit process.

To reinforce the plans through effective implementation process, KMC hopes to made interventions such as requiring builders to submit the reports of soil tests and cube tests (concrete tests) for buildings over 10,000 sq.ft is also being considered. The Disaster Management Department and the Building Construction Permit Department have begun discussions through which recommendations for inspection criteria and policy direction may be suggested for the decision making council.
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