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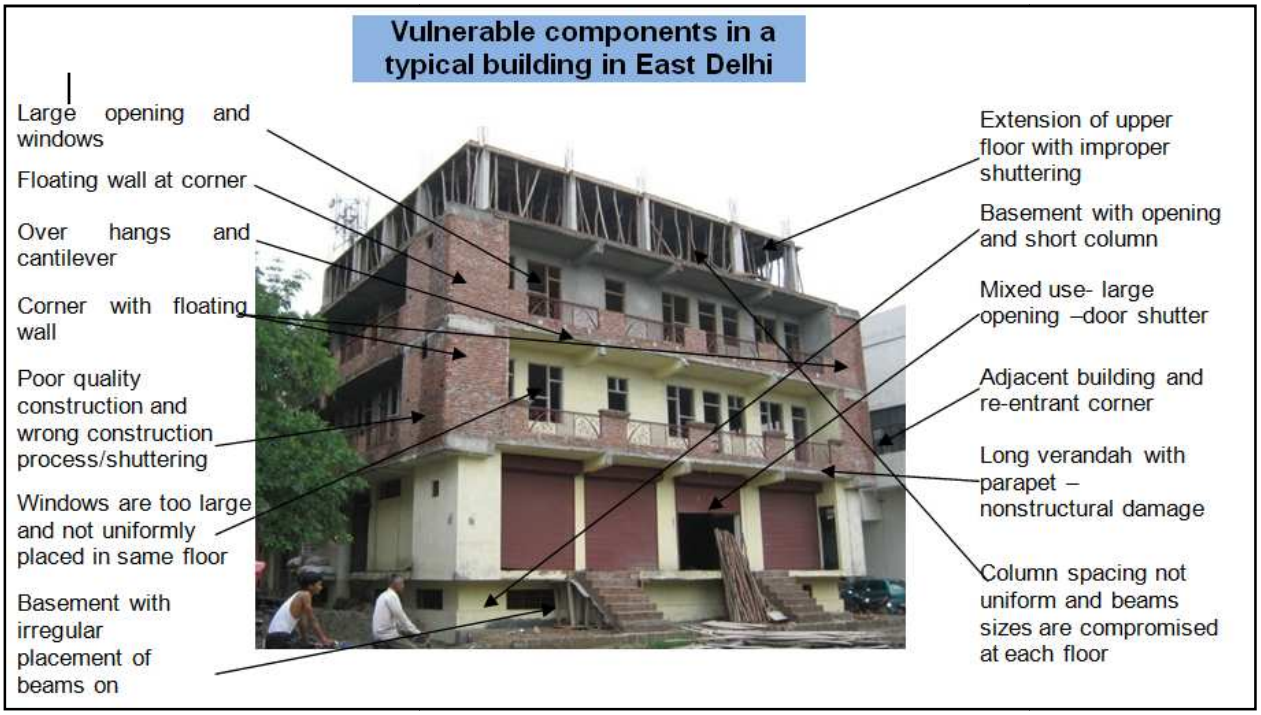
Towards a disaster free India

Seismic Safety Assessment of Buildings in Delhi-NCR by RVS

Venue: NIDM, IIPA campus, New Delhi, Date: July 22-24, 2014



NATIONAL INSTITUTE OF DISASTER MANAGEMENT
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1. Building Safety Mission

To generate awareness among the vulnerable community towards structural safety auditing of buildings and hence forth to augment civic/regulatory bodies in ensuring quality standards in disaster resilient housing.

As far as our understanding of the earthquake goes till date no one can prevent earthquakes from happening again but preparedness and safe building construction practices can certainly reduce the extent of damage and loss.

While at every nook and corner unregulated building constructions spell out potential danger from earthquake and other man-made exigencies in-wait, it is high time to gear up for disaster preparedness aiming to minimize loss of life and property by proper planning in advance so that corrective measures are available to counteract the impact of the hazard before turning to disaster. Visualizing vulnerable built infrastructures in advance and equipping the community to meet it effectively is the hallmark of rational human being.

Building constructions as above are taken up without any consideration of the guidelines and codal practices. These are going to act as mass weapon of destruction during earthquakes. Seeing the scores of vulnerable buildings in the earthquake hazard prone areas of the country it's really difficult to bring accountability to building performance required to be guaranteed by civil engineers.

2. Background

The responsibility to contain building constructions in the country as per prescribed norms is huge. Despite several training and capacity building programs across the country, the increasing trend of damages and loss to national economy in the last two decades must resolve that earthquake preparedness exercises should be taken up as one of the national missions by Govt. of India.

RVS is a qualitative survey with minimal measurements but evaluation of building safety in true engineering sense - needs full details of geometry and stiffness of the structure. To get to know this by simple RVS; is an indomitable task. NIDM did several such trainings in Delhi, following judicial investigation of the Lalita Park building collapse in Nov 2010.

Recalling Delhi's recent past, no. of buildings are collapsed even without Earthquake or any other external shock! Following Building collapse at Lalita Park in Nov 2010, Delhi Govt. formed an inquiry commission. NIDM carried out forensic investigation of the Lalita Park Building collapse, followed by Rapid Visual Screening (RVS) of 10000 buildings in East Delhi with financial support and human resources from MCD. NIDM submitted investigation report to Inquiry Commission in 2011.

Before starting RVS exercise, NIDM carried out 1st RVS training for MCD engineers in March 2011, which later on spread over all the 64 wards for Shahdara South and North, involving more than 100 MCD engineers for more than a month. With the help of few software professionals, NIDM has been developing a customized software utilizing huge database of buildings collected through MCD engineers. The main attraction of the present training program will be to display those findings from RVS of 10000 buildings in East Delhi and make Engineers in Delhi-NCR familiar with the RVS survey. Subsequently local aspects of building vulnerability shall be discussed with the trainees. A format has been prepared by NIDM to keep records of buildings and details will be analysed so that the trainees are able to decide the fate of the building for further investigation. This trg. keeps a balance between class room lectures and hands on exercise, along with some testing exercises in the field.

3. RVS training

The paradigm of sustainable development as a prime necessity in the realm of India's soaring economy, even though it was in existence in different form to developed nations, has been a latecomer to the Indian context. The upsurge of real estate developments across the country necessitates quality monitoring and regulation. While the safe dwellings constructed in the world over has been the kingpin for the advancement of human civilization, it also poses a potential hazard in the event of earthquakes and other related natural hazards. A lacuna in the construction quality brings in loss of life and disastrous economic consequences. Hence, there is a definite urgency to inspect the vulnerability of these built-infrastructures so as to take timely corrective steps to prevent failure. Identifying potential dangers arising out of many ill-conceived structures rampantly

mushrooming in the urban/ city of India is to be taken up with utmost national priority. Rapid Visual Screening (RVS) of building is one such simple tool to classify vulnerability class based on professional judgment. Therefore, a training of trainer's (TOT) program under the broad framework of NIDM was mooted for the Building professionals of Delhi.

Now many state governments, including Manipur, Mizoram, Himachal Pradesh are looking forward to have specialized training to the engineers on RVS with an aim to have a pool of experts who can be engaged in the 1st level of vulnerability mapping of built environment. There are several approaches available in the country

4. About NIDM

The National Institute of Disaster Management is premier organization working in the domain of human resources and capacity development in disaster management. It came into existence in October 2003 by Government of India order upgrading the National Centre for Disaster Management, which was functioning since 1995 at the Indian Institute of Public Administration campus, New Delhi. As per DM Act-2005, NIDM has been entrusted with the nodal national responsibility for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management (More at www.nidm.gov.in)

5. About the course

While Delhi's building bylaws may talk about structural safety, implementation is far from reality. There are no such established safety audit tools available with civic authorities. More than 1800 Civil Engineering Codes are in place but enforcement is lacking. If strict monitoring is not enforced right now, it will be difficult to minimize losses due to earthquake in wait. To ensure that buildings coming up in Delhi are structurally sound and have earthquake resistant measures in place National Building Code- 2005 directed state governments to ensure that all new buildings follow the Indian seismic code (IS: 1893 – 2002).

Over the years, post earthquake studies have provided many important lessons on the societal impacts caused by the intersection of a community's hazard, built, and policy environments. The primary lessons are:

1) Social and physical vulnerability are exposed in every damaging earthquake,

2) Physical vulnerability is caused by flaws in public policies that govern the planning, siting, design, construction, and use of buildings and infrastructure,

3) The performance of engineered buildings and infrastructure in earthquakes is linked to the effectiveness of the public process underpinning the adoption and enforcement of building codes and lifeline standards.

4) Engineered buildings and infrastructure typically perform much better than non-engineered buildings and infrastructure, and

5) Buildings are more susceptible than buried infrastructure to damage from ground shaking, and buried infrastructure is more susceptible than buildings to damage from

permanent ground deformation caused by surface fault rupture, liquefaction, lateral spreading, and landslides.

In seismic risk assessment, estimation of earthquake hazard, structural vulnerability and exposure of building stock are the three equally important components, out of which, the development of inventory databases is the most difficult aspect of damage prediction (ATC-13, 1985). In order to predict the likely impact of an earthquake on the built environment in any part of the country, it is essential to know the seismic vulnerability of the built environment on the affected areas. This information depends on the structural systems of the buildings to resist vertical and lateral loads, performance of similar buildings in past earthquakes, and engineering standards adopted during construction. The assessment of likely impact also depends on the location and distribution of vulnerable building stock in the affected areas

6. Context

There are many buildings in Delhi-NCR that needs their health assessment on regular basis. Every now and then cases of building collapse are mounting up across the country, specially in Metros without any earthquake shaking. While in one hand majority of the buildings are poorly constructed, there is no registered experts/agencies in Delhi-NCR, who shall be held responsible for checking health condition of building stocks. Mushrooming growth of vulnerable structures in the unauthorized colonies where existing building code are hardly applicable. Even in planned colonies, alteration/ addition of floorsto existing buildings have no safety considerations from earthquake.

- Rapid Visual Screening (RVS) followed by the evaluation of Disaster Vulnerability Potential (DVP) of built structures must be a pre-requisite before deciding on remedial cum strengthening measures.

- Buildings officials (Engineers, Architect, Town planners) from leading agencies, such as PWD, BMC, Housing Board…, be trained to assess structural safety with particular concerns about the dangerous buildings in Delhi-NCR area.

These problems are not due to lack of any deficiency in the working of any rules and codes, but concerns the implementation aspect of the same. Advocators of building regulations put forward an argument that city-specific building bye-law would help to ensure compliance of the provisions when once it is put into statute. It needs to be remembered that new rules/act by itself cannot provide any guarantee against the risk of disaster, but what is lacking in the country is not lack of rules and procedures, but an effective attitude to periodic inspection and surveillance system.

The Civic Bodies/Building departments are either subjected or lured to speak volumes in terms of:

- Inadequate funds for maintenance and ignorance in the corrective measures due to seasonal hazard exposure, e.g. Inundation of

basements in several buildings near Lalita Park for more than 2 months

- Inadequate appropriate technical staff for maintenance as there is an unwillingness of the staff to be on maintenance;
- Communication gap among line department when the problems faced at the site is handed over to maintenance
- Mismatching of power delegation among service staffs at the cost of quality worksmanship
- Unfounded attitude towards in-house development of technical expertise in terms of data collection, safety evaluation, onsite inspection by proper instrumentation and deficiency in research and development dealing with building problems

7. Vulnerability Mapping by RVS

Rapid Visual Screening (RVS) is a cheap and fast procedure in assessing the safety of buildings and classifying them according to the risk that they pose in times of strong earthquakes. As per Indian Standard Code the Rapid Visual Screening method is designed to be implemented without performing any structural calculations. The procedure utilises a damageability grading system that requires the evaluator to

(1) identify the primary structural lateral load-resisting system, and

(2) identify building attributes that modify the seismic performance expected for this lateral load-resisting system along with non-structural components.

A building must go for detailed evaluation if the following conditions are met:

(a) The building fails to comply with the requirements of the preliminary evaluation.

(b) A building has six storeys and higher in RC and steel; and three storeys and higher in unreinforced masonry.

(c) Buildings located on incompetent or liquefiable soils and/or located near (less than 12 km) active faults and/or with inadequate foundation details.

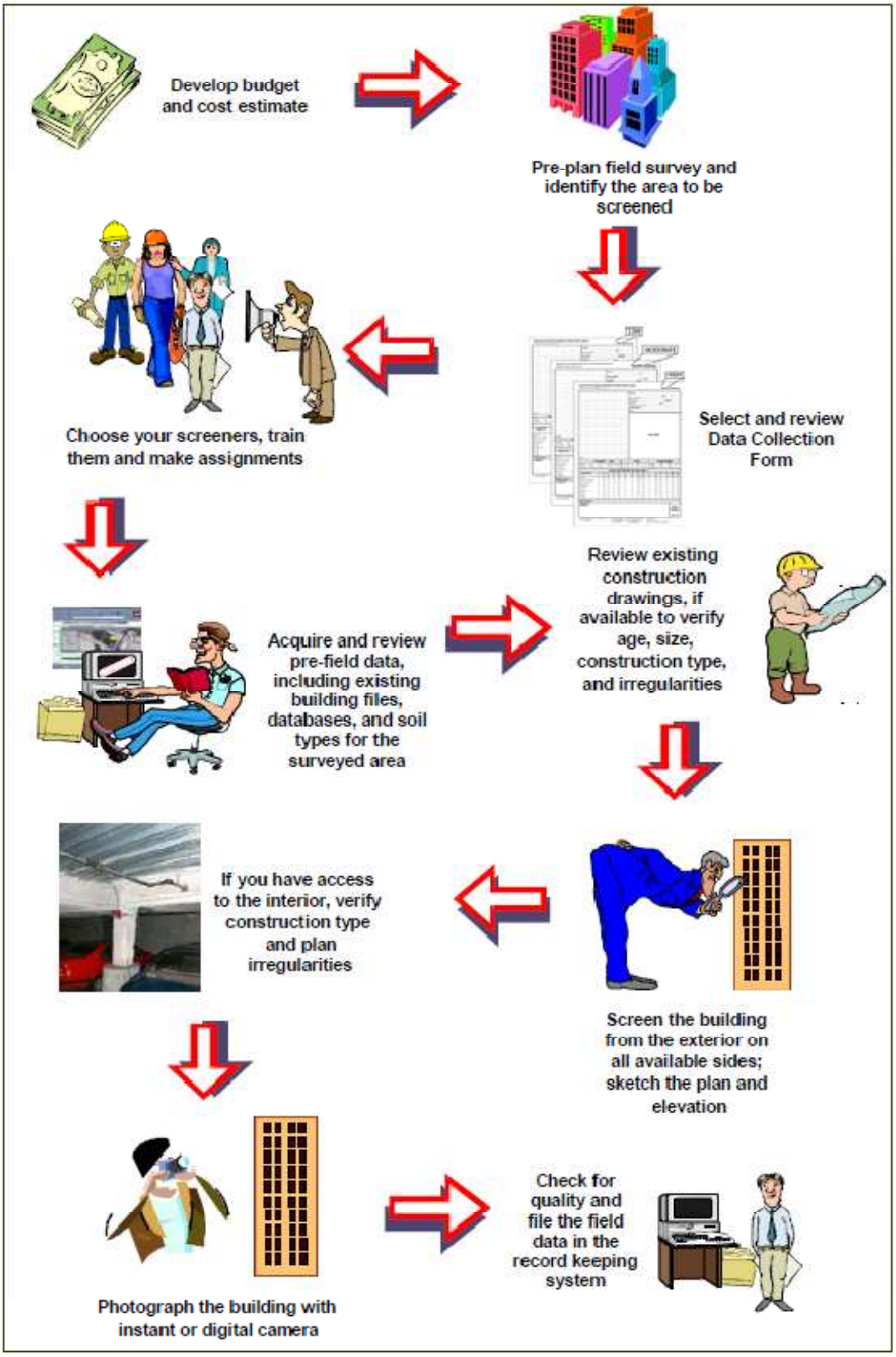
(d) Buildings with inadequate connections between primary structural members, such as poorly designed and/or constructed joints of pre-cast elements.

Visually assessable variables, namely, storey number, cantilever extension, soft storey, weak storey, building quality, pounding effect, hill-slope effect, and peak ground velocity etc. are noted as earthquake hazard category. The inspection, data collection and decision-making process typically occurs at the building site, and is expected to take couple of hours for a building, depending on its size, accessibility and societal response. The screening is based on Code based Seismic Intensity, Building Type and Damageability Grade as observed in past earthquake and covered in MSK/European

macro-intensity. The RVS procedure can be integrated with GIS-based city planning database and can also be used with advanced risk analysis software. The methodology also permits easy and rapid reassessment of risk of buildings already surveyed based on availability of new knowledge that may become available in future .

The main uses of this procedure in relation to seismic upgrading of existing buildings are:

- To identify if a particular building requires further evaluation for assessment of its seismic vulnerability.
- To assess the seismic damageability (structural vulnerability) of the building and seismic rehabilitation needs.
- To identify simplified retrofitting requirements for the building (to collapse prevention level) where further evaluations are not considered necessary or not found feasible.


Develop budget and cost estimate
Pre-plan field survey and identify the area to be screened
Select and review Data Collection Form
Choose your screeners, train them and make assignments
Review existing construction drawings, if available to verify age, size, construction type, and irregularities
Acquire and review pre-field data, including existing building files, databases, and soil types for the surveyed area
If you have access to the interior, verify construction type and plan irregularities
Screen the building from the exterior on all available sides; sketch the plan and elevation
Check for quality and file the field data in the record keeping system
Photograph the building with instant or digital camera

The general sequence of implementing the survey methodology consists of:

- budget development and cost estimation
- selection of buildings to be surveyed
- development of mapping system for survey areas
- walking around building
- photographing the building for identification purposes
- walking through the building and sketching the floor plan
- noting basic data (number of storeys, structural system and materials, major problems, etc.
- determining the score (seismic priority index) for the building according to the procedure presented
- selection of information sources to be included in survey and used in decision-making
- development of record-keeping system
- training of survey personnel
- selection and review of seismic screening form pre-field data collection identification of structure (e.g., address, lot number)

8. Need for preparedness

Built-infrastructures in Delhi-NCR can be ensured safe if adequate precaution and care are exercised at every stage from the point of conception of the building planning till it is translated to granting "**occupancy certificates**".

Such planning would call for correct assessment of the following items:

- Seismic Microzonation of Delhi and making risk map available to city administrators
- Evaluation of the post-disaster impact – advance knowledge of the likely occurrence of earthquake, flood or cyclone.
- To identify the likely effects on property and human beings with a view to assess the damage potential of the disaster.
- Vulnerability analysis and hazard area mapping to identify the most common area prone to such type of disaster.
- Review of organization and machinery for proper upkeep and maintenance of flood control works like dams, embankments, etc.
- Review of the provision of anti-disaster shelter – adequacy of medical aid facility, transportation, food, etc.
- Review of existing method of flood, cyclone, earthquake forecasting system with a view to rectify the missing links and gaps and
- Modernizing the system in accordance with the latest state-of-art, information network, IT enabled services etc..

10. Aspects of the training

- Are buildings in Delhi-NCR earthquake resistant as per Indian Standard codal provisions? If yes, how to check those aspects based on professional judgments?
- Is there any recognized vulnerability assessment tools available with municipal as well as housing authorities in Delhi-NCR?
- Are there any registered professionals who can certify structural safety of buildings based on performance tests/experimentations/investigations?
- How well construction monitoring is done in Delhi-NCR? What are the tools, technique and assessment criteria?
- How well "certification for occupancy" based on criteria as per TCPO guidelines are acceptable to the construction professionals?
- Is there any routine field inspection format available with the building department of MCD/DDA/CPWD/NBCC….? If yes, how effective they are against mass constructions malpractice in the city?
- What are the methodology being followed in keeping authentic records of building construction history, geographic as well as spatial characteristics in GIS platform? Is there any systematic checks on new constructions/alteration/additions that satisfies structural safety norms?
- ONLINE building plan permit are attempted or not for Delhi-NCR? To what extent these permits recognize the poor soil conditions in the Delhi-NCR?
- Are there any norms based on acceptable structural performance of dangerous buildings?
- Any system of peer review of **building plan** (mostly prepared by Architects), **sectional elevation and reinforcement scheduling** (mostly done by structural engineer) and **landscapes** (mostly by Town planners) existing in Delhi-NCR? How to check electrical installation, fire safety and plumbing norms as per NBC-2005?

In above regards, whatever may be the statuesque in Delhi-NCR, it is urgently required to go for Rapid Visual Screening (RVS) of buildings as a first step followed by detailed vulnerability mapping of selected building. For this work proper training and capacity building of engineers, architects and town planners of Delhi-NCR is of prime importance. This module outlines the series of onsite testing/demonstration/inspection of buildings and building materials available in the market followed by set of destructive and nondestructive testing for ascertaining structural safety of buildings in Delhi-NCR.

11. Objectives

- To enhance professional capacity of engineers, architect and town planners of Delhi-NCR on the aspects of seismic hazard and vulnerability assessments of existing built environment in Delhi-NCR
- To make aware of the fallacies in the ongoing construction practices in the city, pros and cons of building permit process and familiarize with correctives measure against seismic and fire safety

- To have onsite experience of random sampling of building materials and construction quality checking and monitoring of new construction
- Familiarize with building defects and diagnostic tools, fire safety, electrical and plumbing installations and promulgation of building bye laws, testing and seismic safety evaluation of some selected buildings in Delhi-NCR
- To bring out a guideline/manual for certifying structural safety against potential hazards in Delhi-NCR

12. Scope of the training

The RVS strategy consists of:

- Awareness and capacity building of Engineers looking after vulnerability of buildings in the seismically active area
- Destructive and nondestructive tools for vulnerability assessment of buildings
- Seismic response evaluation of important establishments and systematic approach to seismic strengthening and retrofitting of buildings
- Hands on training of engineers with simplified RVS format suiting Delhi-NCR built environment

13. Capacity building framework

- **Awareness:** Create awareness about disaster risk reduction and preparedness among individuals and communities through electronic, print and folk media
- **Education:** Include disaster management education in curriculum of schools and professional courses
- **Training:** Train disaster managers at all levels to equip them with necessary knowledge and skills
- **Retraining:** Upgrade knowledge and skills through periodic training and exercises
- **Sensitization:** Sensitize policy and decision makers at national and provincial levels

14. Module Outlines

- Taking cue from frequent collapse of buildings in Delhi, Mumbai, Kolkata even without facing any earthquake shaking it is required to ascertain safety of many such buildings before they face collapse?
- To understand structural and nonstructural vulnerability of buildings from ensuing earthquake threat it is decided to train a pool of professionals based on direct exposure to the building performance test methodology and preliminary safety evaluation by RVS procedure
- To develop a trained manpower/engineers for structural safety evaluation of buildings in Delhi-NCR

This training not only aims at improving practical knowledge base of trainees but also devise an analysis tool for ascribing some vulnerability index to each building surveyed. It

also aims at making proficient engineers in , who shall be assisting Govt. to take corrective measures in the certification of safe and unsafe buildings in the city. Importance would be given to the documentation of entire training process in the form of making a DVD by incorporating all field exercises/demonstration, performance tests and inspection details.

15. Structure of the Training

Classroom lectures by experts

- Introduction to Delhi-NCR Civic facilities, Master plan and infrastructures developments, past disaster events and their impact on national economy
- Disaster management system of Tripura and outlay of the future plans
- Earthquake history of Tripura and vulnerability profile
- Familiarity with building bye-laws and National Building Code - 2005
- Tools and technique for building vulnerability assessment
- Fire safety evaluation of buildings and other important installation
- Nondestructive and destructive investigation of buildings – state of the art development
- Testing and accreditation of building materials

Checking buildings strength – field demonstration

- Vulnerability checking of buildings in Delhi-NCR by Rapid Visual Screening (RVS) followed by Detailed Vulnerability Mapping (DVM) through field inspection and structural integrity testing and onsite demonstration
- 3D scanning and imaging of buildings in Delhi-NCR and interpretation of images by customized software

Case studies

- Lalita park building collapse investigation and some other reports

Hands on exercise and software

- RVS of selected buildings in Delhi-NCR and classification of collected data on special purpose SOFTWARE being developed at NIDM

Training evaluation and feedback by participants

Reporting by course coordinator

Target no.

= 50 Engineers from line agencies in Delhi-NCR

Training Duration

3 days => RVS training (1 day class room instruction and 2 days field tests evaluation and inspection using RVS format)

Venue: NIDM campus, New Delhi (www.nidm.gov.in)

16. Who should attend

Engineers, architects and town planners selected from State PWD, CPWD, Urban development, MCD, DDA, NDMC, HUDA, DUAC, DDMA and other line agencies directly or indirectly dealing with building and infrastructure safety, regulation and sanctioning of building plans.

17. Mode of training

- **Classroom lecture** by experts with case examples and evaluation of vulnerability from seismic and fire hazards
- **Onsite evaluation** of building vulnerability using Rapid Visual Screening (RVS) based on prescribed format on 1st and 2nd day and presenting the outcome on 3rd day.
- **Use of simple NDT instruments** at the site for checking structural health conditions of buildings
- **Mapping of built facilities by 3D scanner and imaging**
- **Reporting of safety status** of building based on data collection by the participants and interpretation of the same through a customized software with **professional judgement**
- **Training evaluation** by participants

18. Evaluation of the programme

The final session of the programme will be devoted to discussion, evaluation of the course content and valediction. The participants will be supplied with an evaluation proforma, which may be completed and handed over to the Programme staff.

19. CERTIFICATE

A Certificate will be awarded to each participant on successful completion of the programme.

Realising that:

1. Building Plans for common people are usually sanctioned without structural details. Having an onsite check on construction is a mere formality.
2. Despite the country is having well developed earthquake codes since 1962, the common temperament has been more on business motivated than safety assurance
3. Building constructions in the earthquake prone areas of the country are managed by unorganized sectors, consisting of mason, contractors and quacks
4. Several buildings collapse across the country even without any earthquakes but they are mostly due to wrong construction methodology being followed!
5. Multi-storey framed buildings in many new urban areas are having stilt/soft storey, irregular columns, inebriated shear wall and foundation – these are vulnerable to earthquake. For instance, Bhuj Earthquake (2001) affected many multistory buildings in Ahmadabad, which is more than 200km away from the epicenter.
6. Buildings that are constructed along the property boundaries with eccentric footings becomes more vulnerable due to pounding effect
7. Buildings that are poorly constructed, added/altered/ extended/ dismantled without proper expertise are vulnerable to earthquake shaking

By the end of training, the participants should be able to:

- Understand basics of structural safety assessment and draw lessons from the past earthquakes
- Identification of seismic vulnerability of buildings across the country
- Familiarity with Fire safety and preventions measures in Delhi-NCR
- Seismic Vulnerability of buildings by conducting field survey based on simple format
- Usage of automated RVS software for data input, calculation and representing the same in GIS layers
- Earthquake related codes in India and National Building Code-2005
- Familiarity with nonstructural hazards identification and mitigation measures
- Understand basic methods for reducing earthquake hazards of overhead water tanks, building appendages, gas lines, brick veneer, and other nonstructural as well as architectural components.
- Evaluate vulnerability of buildings by NDT – ultrasonic, rebound hammer, reinforcement scanner
- Mapping of built-environment by 3D scanner and imaging and familiarity with special purpose software for facility mapping using Google Earth
- Evaluation of vulnerability class based on sample building survey and decision making on the seismic status of "dangerous buildings" in Delhi-NCR

For suggestions please contact

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Towards a Disaster Free India

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Training Schedule (tentative)

Title: Seismic Safety Assessment of Buildings by RVS

Date: July 22-24, 2014

Venue: National Institute of Disaster Management, IIPA Campus, New Delhi

Time	Tuesday July 22, 2014	Wednesday July 23, 2014	Thursday July 24, 2014
9:30-10:00	Registration		
10:00 -11:15	Inaugural function Seismic Vulnerability of NCR Delhi -1 **[Guest: Aqil Ahmed, MCD]**	Structural safety assessment of dangerous buildings- Case Study **[CG]**	RVS data collection and surveillance by web GIS **[CG]** Demonstration of WeatherBug – forecasting cloudburst/lightning – Mr Kumar Margasahayam, **ENI - Bangalore**
11:15-11:30	**Tea break**		
11:30-13:00	Seismic Vulnerability of NCR Delhi **[CG]** Data & Infrastructure mapping of Delhi **Anirudhha Roy**	Fire/building safety auditing and Compliance [**CG]**	Development of city specific guideline for EQ. safe construction [**CG]**
13:00-14:00	**Lunch break**		
14:00-15:15	Construction materials and quality checking **Yogesh Barot, Ambuja**	Demonstration of field equipments for Rebar location+ NDT **Arun Madhok,** [**Ambuja Cements**]	Consultation on RVS Format for RCC buildings **[CG]**
15:15-15:30	**Tea break**		
15:30-17:00	3d-imaging of city **Col. A.K Singh**, RSiSoftech Consultation of RVS format for RCC buildings [**CG**]	Mapping of vulnerabilities by 3D laser scanner and imaging, NDT for buildings diagnostics **Nikhil Saxena** [**APIPL]**	Panel Discussions - Experience sharing and way forward for RVS tools [**CG+]** Course evaluation and valedictory function
17:00-17:15	**Summary of day's proceedings**		