

Lessons Learned from Retrofitting of Private Houses in Nepal after the 2015 Gorkha Earthquake



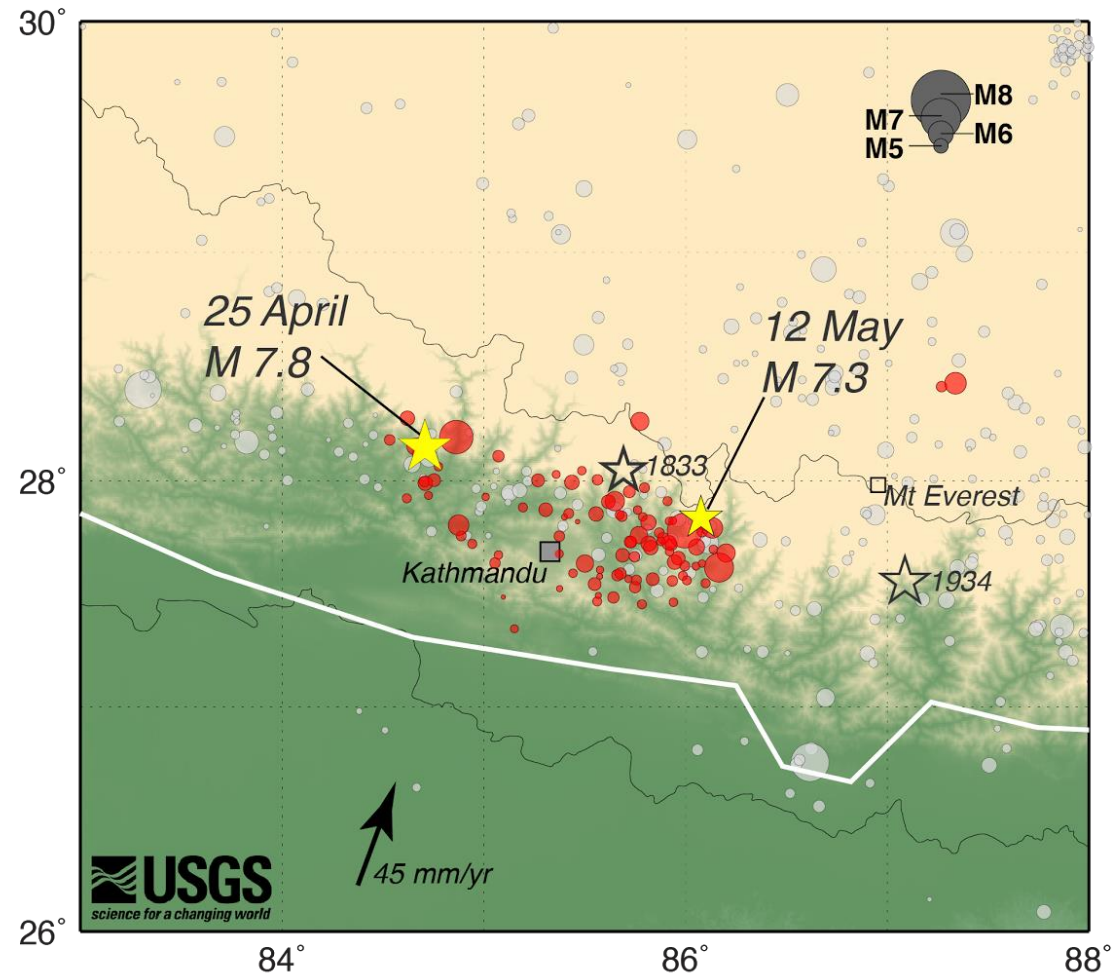
Bipin Kumar Gautam
Structural Engineer

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Nay Pyi Taw
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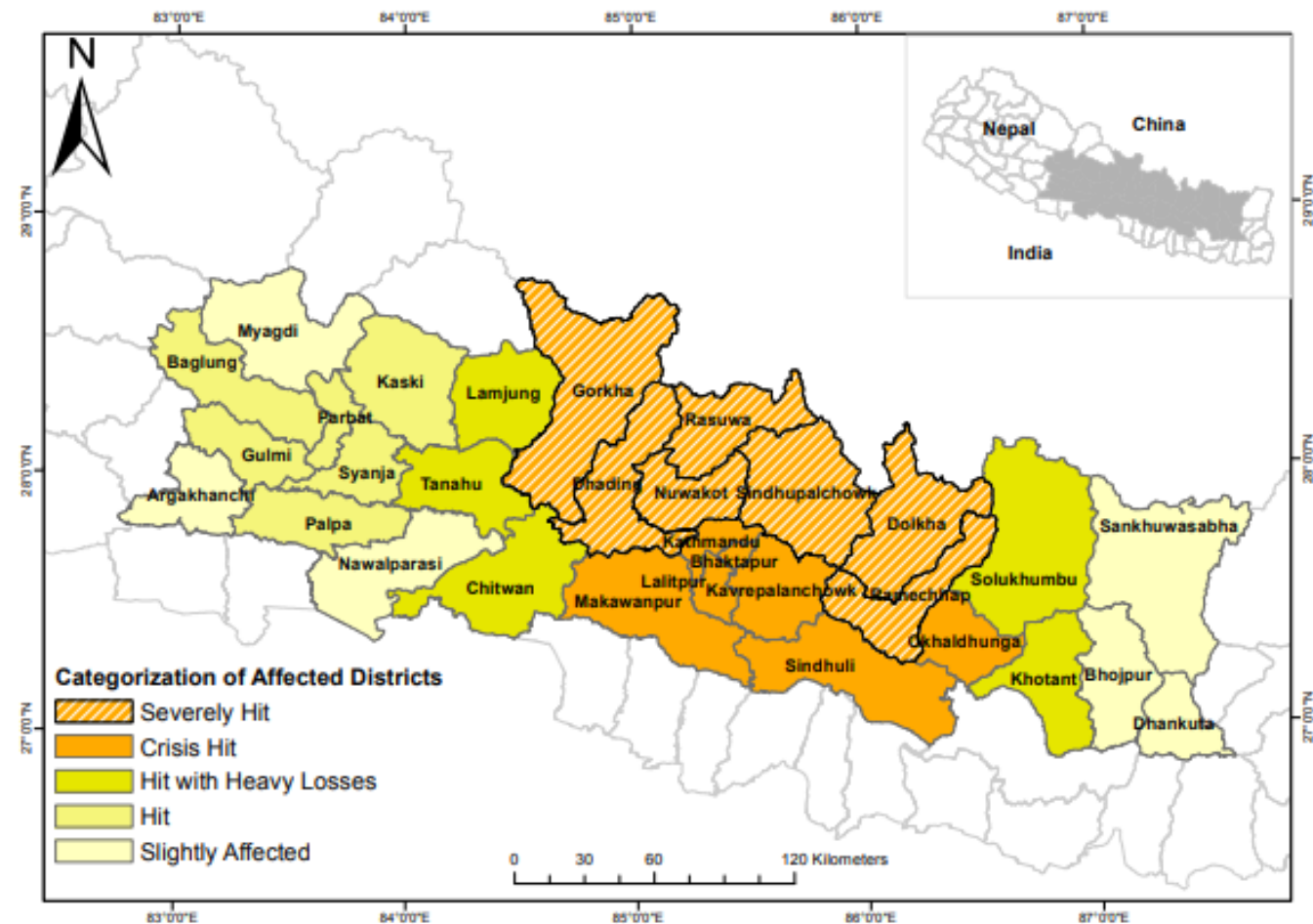


**NEPAL
ENGINEERS'
ASSOCIATION**

2015 Nepal Earthquake Overview



Source: U.S. Geological Survey



Source: Nepal Earthquake 2015: Post Disaster Need Assessment

Earthquake Impact

Human Impact:

- **Deaths:** 8,790 people
- **Injuries:** Over 22,300 people
- **Displaced:** Around 2.8 million people are displaced
- **Affected population:** 8 million people in 31 districts (out of 75)

Housing:

- Over **498,800** houses were fully destroyed
- More than **257,000** houses were partially damaged

Infrastructure damage:

- Schools: 7,923 schools (49,681 classrooms) and 70 universities and colleges
- Health facilities: 1,200+ damaged

Cultural heritage:

- 750+ monuments damaged, including UNESCO World Heritage Sites

Nepal Engineer's Association



- Deployed more than **3000 engineer's** for the **damage assessment**
- Conduct **damage assessment training and assessment work**
- Coordination with the government to manage **large number of human resources** in the very short period of time
- **Promoting resilient reconstruction practices including the retrofitting techniques**
- Strengthening the **professional competencies of engineer's community**

Retrofitting Scenario



- Retrofitting Beneficiaries: **78,033 households**
- **Large stock** (more than 3.5 million) of similar non-engineered **vulnerable houses** spread across Nepal
- **More than 70%** of EQ affected Houses were stone masonry in mud mortar
- As for 2021 Census: more than **60% buildings are of Masonry** (Stone and Brick Masonry), more than **10% are with RCC**, more than **10% timber houses**
- Reconstruction and Retrofitting Beneficiaries get **300K Nepalese Rupees Grant** and **100K Nepalese Rupees Grant** respectively

Key Elements

Key Actors

Government

House
owners

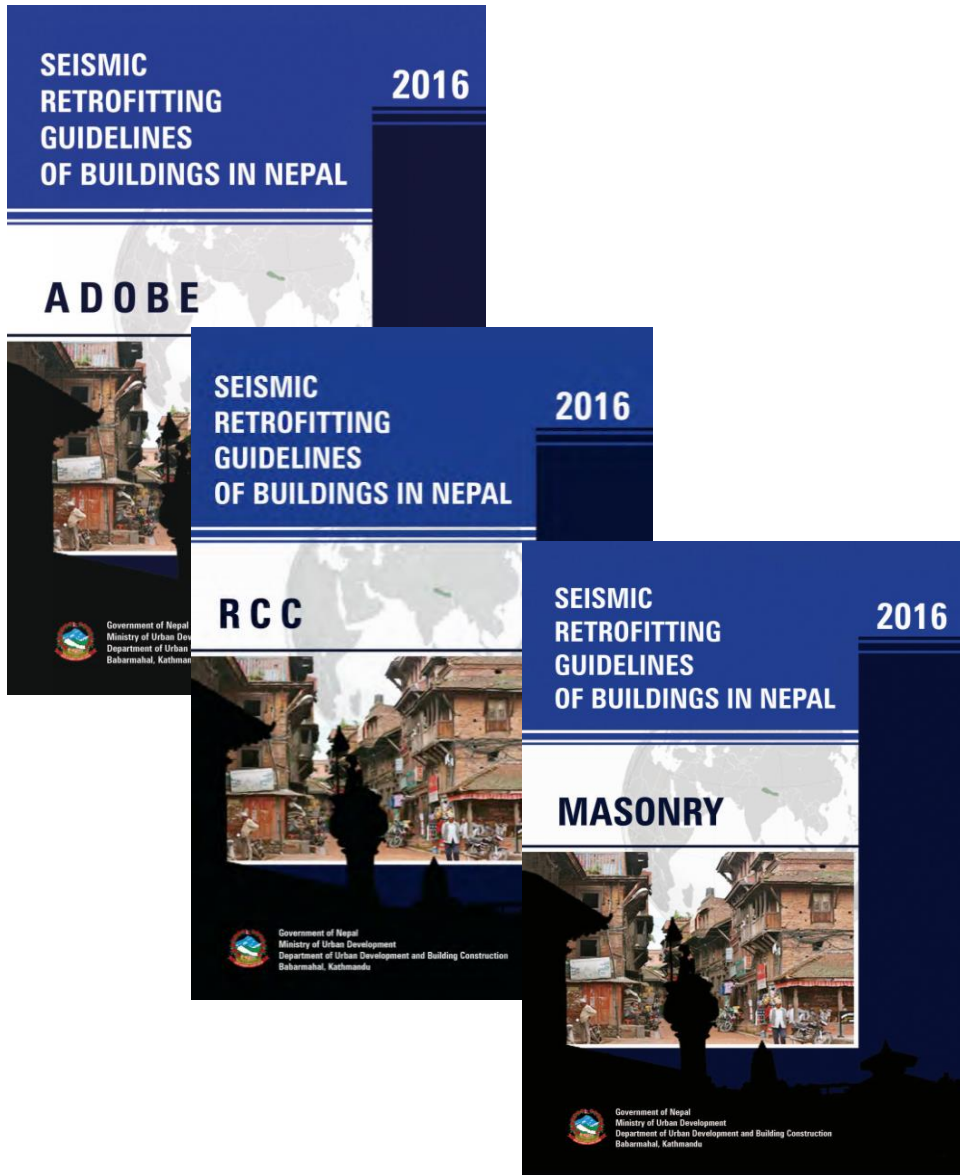
Community/
private sector

Technicians/
Partners

Retrofitting program can only be successful if:

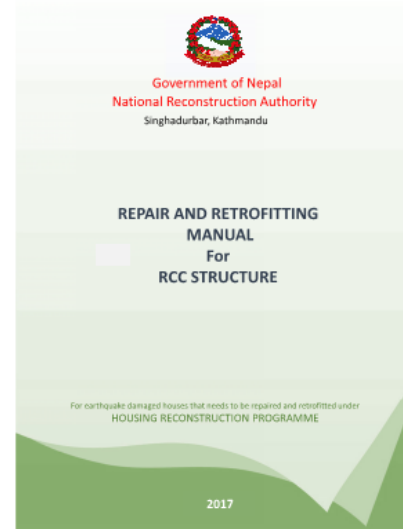
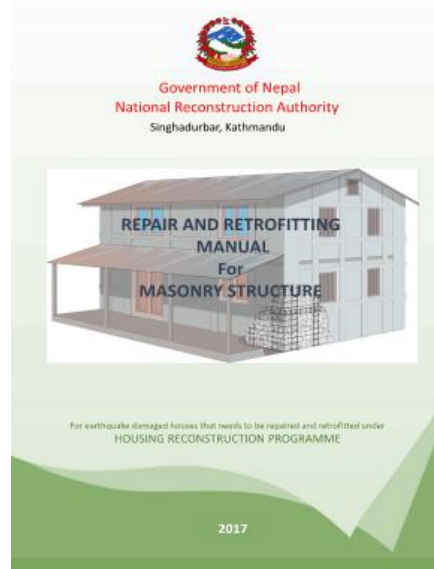
- The solutions are **easy to understand and replicate**
- Availability of **trained human resources** like masons and engineers
- The solutions are **affordable and culturally acceptable**
- **People centred approach** - House owners sensitized to take action to increase their seismic safety
- **Policy makers promote retrofitting** through technical and financial packages

Technical Strength



- **Supports engineers** in design of retrofits
- Takes engineering **time and effort** to design a retrofit
- Requires **experienced engineer to design retrofit** using the guidelines
- The guideline can be used to **support calculations** required for producing easy to use guidelines and manuals

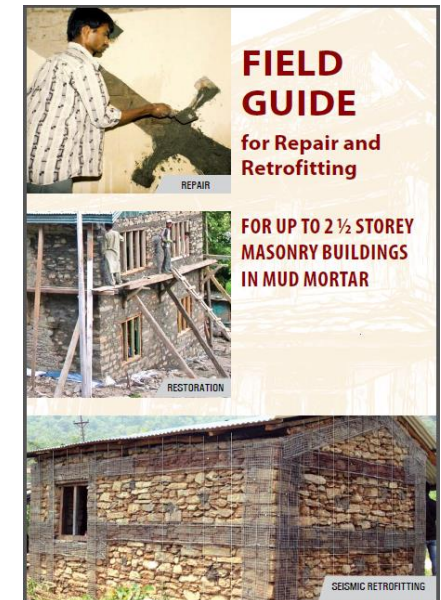
Technical Strength



ENGINEERING MANUAL: STANDARD TYPE DESIGN RETROFITS
STONE MASONRY WITH MUD MORTAR (SMM)

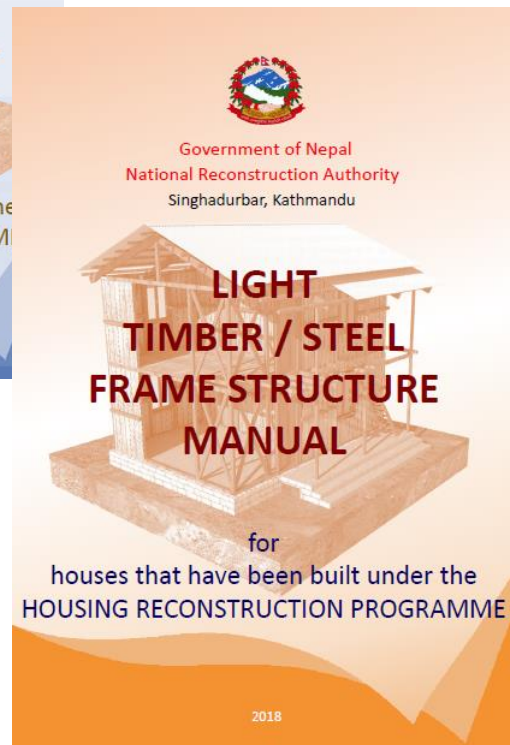
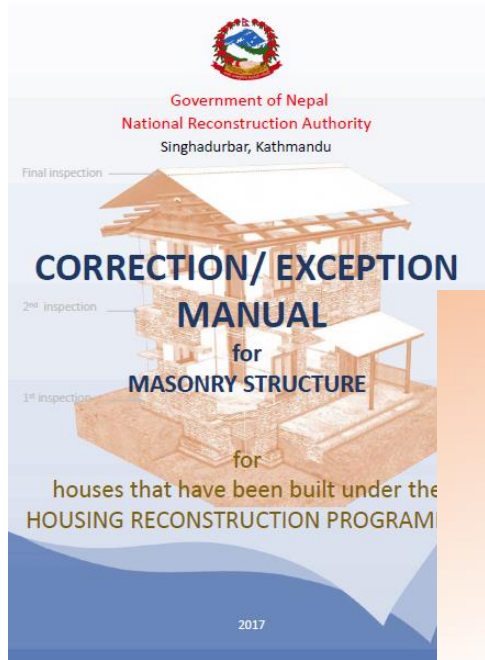


Primary elements of the standard type retrofit design:
(Top row: althing beams, side strips;
Bottom row: ring beams, lightweight gables)



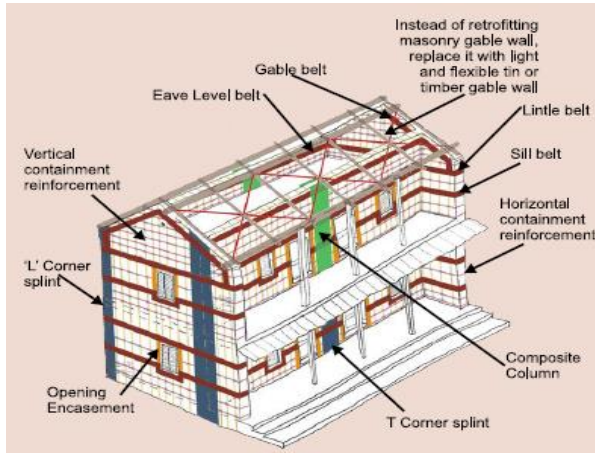
- Quick and **simple to use**
- Provides a **menu of solutions with different technologies**
- Suitable when the demand for **retrofitting is large** as in a post disaster context
- Suitable when **homeowners cannot afford the services of experienced engineers**

Technical Strength



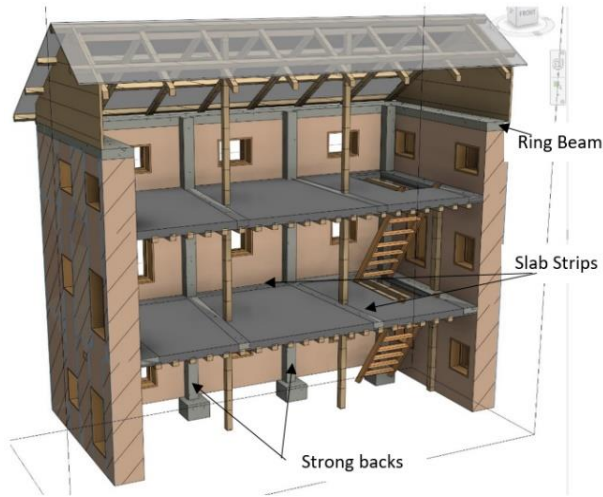
- **Correction/Exception Manual:** Manual addressed the problems in the reconstructed houses after Gorkha Earthquake and their remedial solutions
- **Light Timber/ Steel Frame Structure Manual:** Manual provides simplified calculations and correction of different types of timber building

Features of Retrofit Manuals



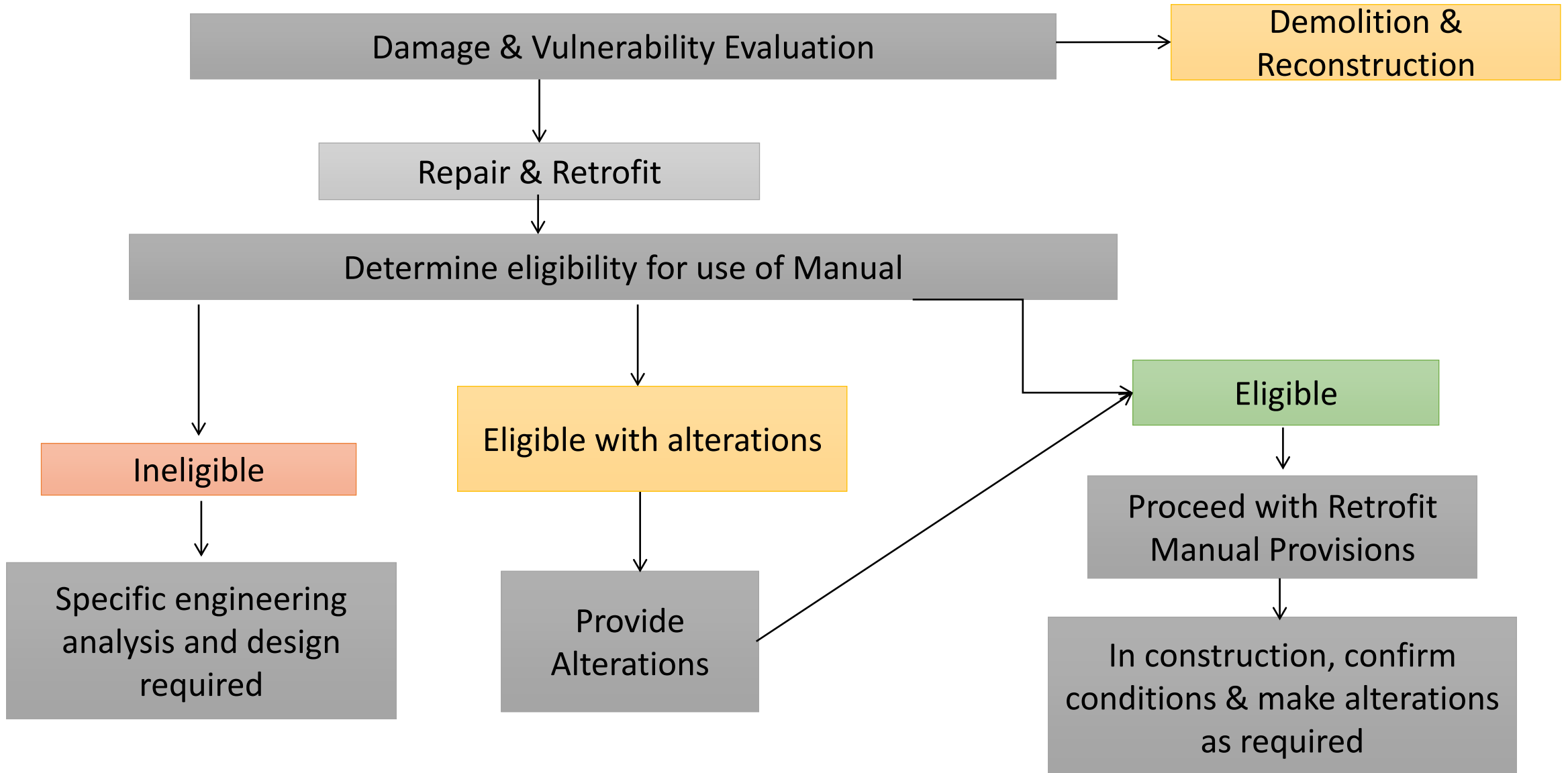
- Supports engineers to **provide quick and ready to use guidance** on house retrofitting
- Describes **vulnerability/deficiencies** of buildings
- Provides **repair methods** according to damage grade
- Describes **retrofitting approaches** to address the vulnerabilities

Features of Retrofit Manuals



- Provides **example designs for typical houses** retrofitted
- Provides **construction sequence** to implement the each retrofit approach
- **Retrofitting cost** for each technology
- **Norms for the rate analysis** of the items through calculation and validation

General Methodology



Organizational Structure

(for private housing reconstruction/ retrofitting)

National Reconstruction
Authority (NRA)

- Develop all required policies
- Monitoring and all processes

Central Level Project Implementation Unit
Building (CLPIU)
(Ministry of Urban Development)

- Responsible for developing all technical documents, training, and capacity building, providing technical solutions
- Recruiting and mobilization of technical resources
- Monitoring of the process

District Level Project Implementation Units
(DLPIU)

- Mobilization of technical people (engineers and sub-engineers, masons, social mobilizers) to the Local level
- Technical advice to owners/ masons
- Responsible for the inspection of the reconstructed/ retrofitted houses
- Responsible for providing grant trances

Technical Human Resource

- **At least one engineer is deployed at one Municipality;** many more depending upon the number of households
- **Technical team at the District level (DLPIU) with at least one structural engineer expert** (more experts based on the number of beneficiaries), who provide instant solutions/ design at the field level
- There is a **monitoring and evaluation expert** for each district deployed by the CLPIU
- Still, the problem is unsolved, The problem will be sent to CLPIU, where there is a **technical task force** mandated to resolve the technical issue ASAP.
- If there is any issue related to policy, send it to the NRA

There should not be any problems unsolved..

Capacity Building



Trainings of engineers and sub-engineers on:

- Basic concept of retrofitting
- Different types of retrofitting technologies
- Designing of retrofit solution for masonry structure
- Inspection of retrofitted houses



Engineers and sub-engineers trained through **OJT: 816**

Engineers and sub-engineers trained (**theoretical**): **2604**

Mason trained on Retrofitting: **2265**

Public Outreach and Awareness



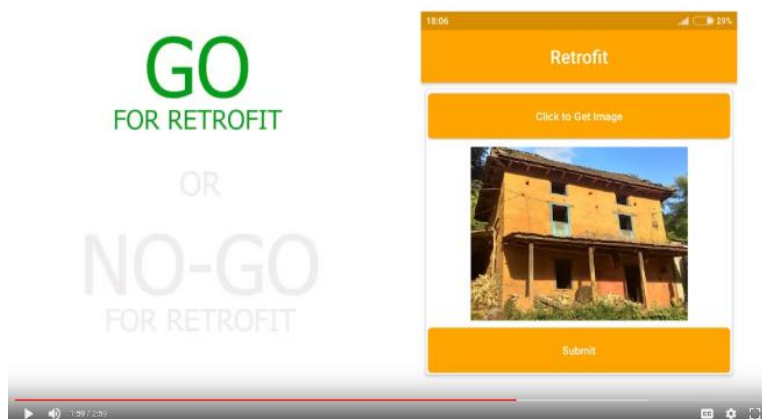
Videos: Importance of retrofitting, shock table demonstration, initiating retrofitting, etc.

Public Service Announcements: Short animated videos to give basic information on what is retrofitting

Booklets: Ten key points to remember during retrofitting, visual guideline on repair and retrofitting

App: For seismic assessment using artificial intelligence, provides possibilities in strengthening the buildings and solutions

Posters/ Flyers: raising mass awareness on both technical/ financial aspects of retrofitting



Shown by Example



Retrofitting of large scale **Heritage Buildings** including **Central Administrative Building (Office of Prime Minister of Nepal)**

Model buildings were retrofitted in few local level through On-the Job training

Retrofitting of **Vulnerable beneficiaries' buildings (grant)**



Stocktaking

Reconstruction

- Agreed Beneficiaries: 843,344
- Construction Completed: **91.46%**

Retrofitting

- Agreed Beneficiaries: 35,222
- Repaired/ Retrofitted house: **5.78%**

Challenges and Learnings



- **Lack of risk awareness** and need of retrofitting – still using **vulnerable houses**
- **Willingness of retrofitting beneficiaries to transfer into reconstruction** – 300K vs 100K
- **Inadequate grant amount - grant driven** rather than risk realization
- **Misconception** - technically very difficult, not implementable
- Limited examples on **retrofitting for public confidence building**

Challenges and Learnings



- Lack of technical **human resources** and **technologies**
- **Lack of conducive policy environment for promoting retrofitting-** Socio technical/ financial packages
- Lack of access for finance - Soft loans, collaterals
- **Complexity in the retrofitting in the urban areas:**
 - Scale of the building
 - Cost of implementation
 - Strict building bylaws
 - Row houses, etc.

Way Forward



- **Comprehensive awareness campaigns** at all level
- **Sensitization and build ownership** of the stakeholders
- Retrofitting Approach: **Incremental retrofitting** levels of seismic safety
- Policymakers take **retrofitting** as highly priority agenda **for risk reduction**
- Preparing **'Ready to use designs'** for mass replication

Way Forward



- **Institutionalization of trained human resources (engineers/ masons)** by formation of retrofit Cadre up to local level
- Create **mobile technical teams** to support up-scaling at local level
- Research on **retrofitting of prevailing building typologies**
- Retrofitting included in **engineering/vocational training curriculums**
- Improve supply chain and assure quality of the construction materials



Any questions?