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2015年4月ネパール地震(Gorkha地震)における建物被害に関する情報収集調査速報

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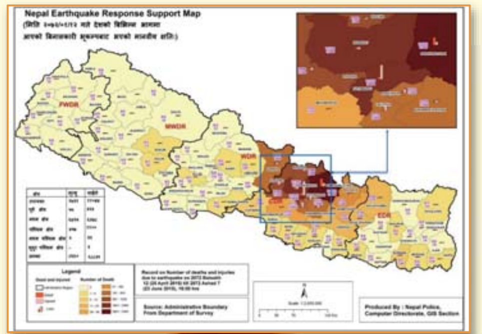

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表紙写真 ・・・・ Casualties and Damage of Masonry Housing Caused by Gorkha Earthquake.

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Flash Report on the Damage of Masonry Housing Caused by Earthquake in the case of Gorkha Earthquake, 25 April 2015

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Abstract

An earthquake with a magnitude of 7.8 (*Mw*) occurred at 11:56 NST, (local time) on 25 April 2015, in the central part of Nepal (Gorkha). The National Research Institute for Earth Science and Disaster Prevention (NIED) organized a damage survey team and dispatched it to the affected area during 26 May to 3 June for the investigation into the damage and collection of information and data. This report outlines the findings of this investigation undertaken by the NIED team on the various aspects of the earthquake disaster in the Kathmandu valley. The primary purpose of the first survey is to collect the current statistical information of the damage brick / stone masonry hosing and to confirm availability of data and their sources for the following surveys. The motivation of the survey is to obtain ground truth data to calibrate and improve the wide-area damage estimation system using satellite data under development by NIED. We also carry out actual building damage survey by ourselves at selected areas. We collect information of structural differences between damaged and non-damaged buildings, their classifications and distribution, time-dependent demography, and other social aspects specific to Nepal.

Key words: Gorkha Nepal Earthquake, Kathmandu, Masonry, Ground truth

1. Introduction

An earthquake with a magnitude of 7.8 (M_w) occurred at 11:56 NST, (local time) on 25 April 2015, in the central part of Nepal (Gorkha). The epicenter was east-southeast of Lamjung, 77 km south-west of Kathmandu, 28.15 at the north latitude and 84.71 at the east longitude, and the depth was 15 km (USGS). According to the statistics by The Nepal Police on 22 June the number of deaths 8,660 and injured 21,952 for the main shock and deaths 172 and injured 3,470 for the aftershock. It was also reported that more than 5,000,000 buildings and houses were damaged and about half of those had which collapsed. This earthquake was officially named as The 2015 Gorkha Nepal earthquake, since the hypocenter was located in the Gorkha region.

A major aftershock with a moment magnitude of 7.3 (M_w) occurred at 12:51 NST on 12 May 2015. The epicenter was 75 km noth-east of Kathmandu and near the Chinese border, 27.82 at the north latitude and 86.08 at the east longitude, and the depth was 19 km (USGS).

The National Research Institute for Earth Science and Disaster Prevention (NIED) organized a damage survey team and dispatched it to the affected area during 26 May to 3 June for the investigation into the damage and collection of information and data. This report outlines the findings of this investigation undertaken by the NIED team on the various aspects of the earthquake disaster in the Kathmandu valley (**Fig. 1**).

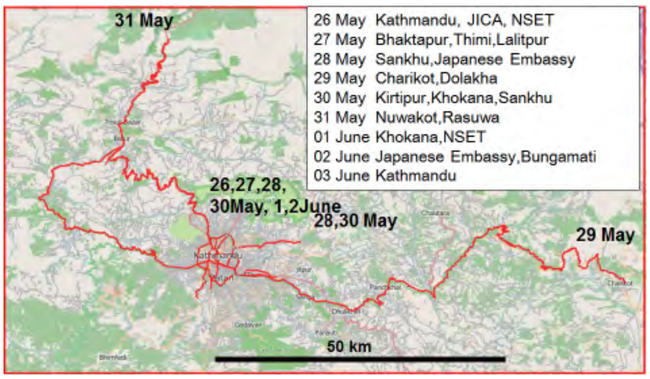

Fig. 1 Survey Route.
(OpenStreetMap https://www.openstreetmap.org/)

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At the beginning of the report the tectonics and the seismicity are briefly introduced, and the characteristics of the recorded earthquake ground motions are discussed from the view point of the fault rupture mechanism. The India plate sub-ducts along the Main Himalayan Thrust beneath the Eurasian plate. The Main Himalayan Thrust is dipping at a low angle towards north. Tectonics of the Himalaya region are expected to most continue to rise more than 1 cm/yr.

There were three kings in the Kathmandu valley. Their palaces were in Kathmandu, Bhaktapur, and Lalitpur / Patan. The difference between the renovation works done at these palaces was significant (Not for the historic structures of the old royal palace). Damage to the Old Sanku was serious, the brick and cement mortar houses were seriously damaged. These structures did not have reinforced concreate (RC) columns.

A numerous number of huge slope failures which occurred in mountainous areas and buried villages and valleys, which resulted in the loss of many lives. Many houses that were caught in landslides, had limited damage. However, the whole scope of the slope failures is not clear at this present time, because any detailed and total survey in the mountainous area as not been carried out. Thus, the number of causalities will be increase as they are found.

2. Tectonics of Nepal and Earthquake Ground Motion

2.1 Tectonic Interpretation of the 2015 Gorkha Nepal Earthquake on April 25, 2015

The India plate sub-ducts along the Main Himalayan Thrust beneath the Eurasian plate. Among the most dramatic and visible creations of plate-tectonic forces are the lofty Himalayas, the two large landmasses of India and Eurasia, driven by plate movement to collide. Because both these continental landmasses have about the same rock density, one plate could not be sub-ducted under the other[1]. Thus, the Main Himalayan Thrust is dipping at a low angle 6° - 14° towards north (Mukhopadhyay, 2014) [2]. Tectonics of the Himalaya region are expected to continue to rise more than 1 cm/yr[1].

2.2 2015 Gorkha Nepal Earthquake and Risk Assessment Results of JICA 2002

During “The study on earthquake disaster mitigation in the Kathmandu Valley (JICA, 2002)” [3], hazard analysis and damage analysis were conducted. The ultimate purpose of this earthquake disaster analysis is to recognize the phenomena involved when an earthquake occurs near the Kathmandu Valley in the future. Based on the disaster scenario, a disaster prevention plan can be established. The scenario earthquake fault models are shown in **Fig. 2.2**.

Nepal lies on an active seismic zone ranging from Java – Myanmar – Himalayas – Iran and Turkey, where many large earthquakes have occurred in the past. The historical earthquake catalogue shows the high seismicity along the Himalaya and also the occurrence of huge earthquakes. Kathmandu has suffered damage due to earthquakes several times, among them the 1934 Bihal-Nepal earthquake caused the most serious damage. The damage of the earthquake will be different depending on the type and location of the earthquake, such as a huge earthquake outside of the Valley and a small to middle-scale one within the Valley. In the study, four scenario earthquakes have been set, among them two hypothetical earthquakes were chosen in JICA 2002 report.

1) 1934 earthquake (M_w 8.4)
2) Mid Nepal Earthquake (M_w 8.0)
3) North Bagmati earthquake (M_w 6.0)
4) Kathmandu Valley local earthquake (M_w 5.7)

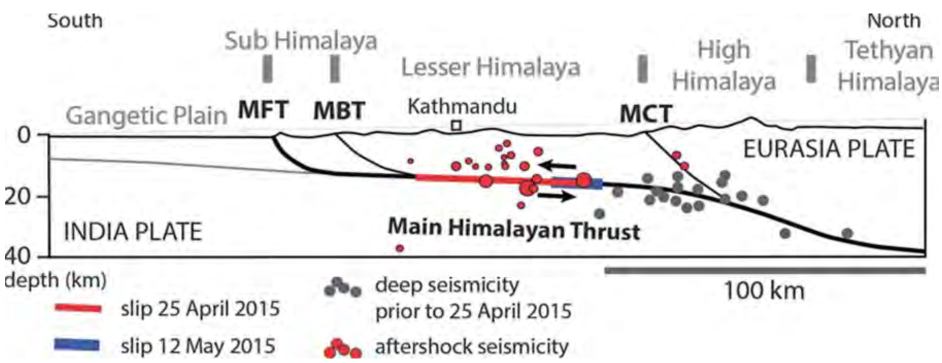


Fig. 2.1 Cross-section of the Main Himalayan Thrust (USGS: The April-May 2015 Nepal Earthquake Sequence)
Generalized cross section showing the approximate locations of slip during the 25 April and 12 May 2015 ruptures on the Main Himalayan Thrust, and approximate aftershock locations of both events.
MFT = Main Frontal Thrust, MBT = Main Boundary Thrust, MCT = Main Central Thrust.
Cross section generalized after Lave and Avouac, 2001 and Kumar *et al.*, 2006.

The First case is the 1934 earthquake (M_w 8.4) model, in which the 1934 Bihal-Nepal Earthquake fault model is in the blue area. The second case is namely the Mid Nepal Earthquake (M_w 8.0), which was the most devastating one which is in the green area. This model was is based on seismic gaps in Nepal. The third model is the frequent occurrence area of the small earthquakes in the near northern part of the Kathmandu Valley which is in the red area. This case correspond with the high-frequency component area of Yagi's model. Also, a major aftershock with a moment magnitude of 7.3 (M_w) on 12 May 2015 occurred to the close hypocenter in this model. The fourth model is based on the clear lineament in the Kathmandu Valley, as small as magnitude 5.7 (M_w).

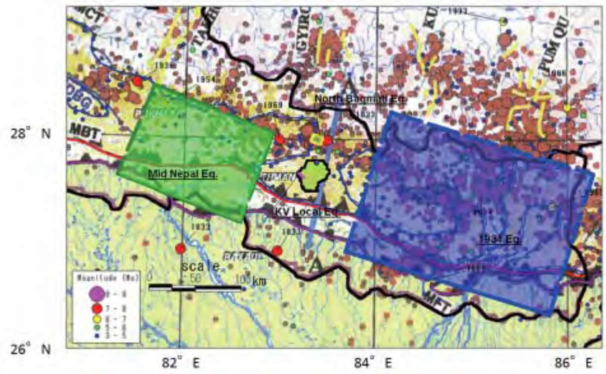


Fig. 2.2 The scenario earthquake fault models (JICA2002).

3. Historical Palace and Building in Urban Area

During the Malla dynasties up to 1768, there were three kings in the Kathmandu valley. Their palaces were in Kathmandu, in Bhaktapur, and in Lalitpur/ Patan. The center areas of these palaces are called "Durbar Square".

3.1 Bhaktapur

"Bhakta means" Devotee in Sanskrit, and "pur" means city. Thus, Bhaktapur is the city of devotees. Bhaktapur's Durbar Square is a conglomeration of pagodas and Sikhara style temples grouped around a 55 Window Palace of brick and wood (**Fig. 3.1**).

Many of Sikhara in Bhaktapur's Durbar Square were severely damaged. The steel frame reinforced Chayslin duga temple (left) (**Fig. 3.2**). This temple was no damaged. During the 1934 earthquake Chyasilin Mandap was completely destroyed. Architects Götz Hagmüller and Niels Gutschow set about rebuilding this temple due to the metal reinforcements by GTZ fund. The Vatsala temple (center), which is Newar style temple, ca.1690, was destroyed. Yaksheshvara temple (right) survived.

Harisankara temple

This structure materials are polished decorative bricks of high quality terracotta for lintels of doors and for decorative layers are integrated into the facades (**Fig. 3.3**). Inside materials are unburned bricks and timber frames. This sikhara had to be demolished later.

Chasin Mandapa and Siddhilakshmi Shikhara

Chasin Mandapa (left) was broken in the lintel (**Fig. 3.4**). Siddhilakshmi Shikhara (right) survived, except the top of finial. This temple's construction used stone and Indian style. This style developed in India during the late 6th century, it only appeared in Nepal during the late Licchavi period, 9th century. There was no damage to the statues of guarding lions and the steps leading to the main entrance. The Fasi Dega was destroyed (**Fig. 3.5**). The large, white Fasi Dega Temple was dedicated to Shiva and it was one of the tallest temples in the second part of Bhaktapur Durbar Square.

Taumadhi Square

Nyatapola Temple, which is a five-storied pagoda, was built by King Bhupatindra Malla in 1702 (**Fig. 3.6**). This is one of the tallest pagoda-style temples in Kathmandu Valley and is famous for its massive structure and subtle workmanship. This temple survived in an earthquake in 1934. This temple remained with a minimum of damage, the reliability of the building technology is being evaluated. The Bhairavnath temple was destroyed by an earthquake in 1934 and subsequently rebuilt.

Dattatreya Square

Dattatreya square in Bhaktapur suffered only one small casualty in terms of collapsed temples. The main Dattatreya temple and others still stand. This temple was originally built in 1427 and is dedicated to Dattatraya, an incarnation of Vishnu.

The God Bishnu festival is held in the Datrataya Temple (**Fig. 3.7**). Usually, this festival is organized every year from July to August. In front of this temple, two statues watchmen/ guardians are standing, who provide against evil and disasters. Two watchmen hold Grakata, which is the preferred weapon of Lancers.

The Nepal calendar is currently 2072. Thus, Nepal 1990 B.S. (Bikram Sambat) correspond to 1934A.D. State, this temple collapsed but has not been rebuilt (**Fig. 3.8**). If such non-reconstruction of historical buildings that have been lost during earthquakes does not proceed, it will be a major blow to the future Nepal's tourism-oriented country.

Fig. 3.1 Bhaktapur before / after the earthquake (Photo. by T. Ohsumi), before / after the 1934 earthquake (Courtesy of MoHA).

Fig. 3.2 Rinforced Chayslin duga temple (left) by steel frame, Vatsala temple (center) was destroyed and Yaksheshvara temple (right) survived (Photo. by T. Ohsumi).

Fig. 3.3 This sikhara was demolished (Photo. by T. Ohsumi).

Fig. 3.4 Chasin Mandapa (left) and Siddhilakshmi Shikhara (right) (Photo. by T. Ohsumi).

Before the earthquake After the earthquake

Fig. 3.5 The Fasi Dega was destroyed (Photo. by T. Ohsumi).

Fig. 3.6 Nyatapola temple (left) and Bhairavnath temple (right) are no damage (Photo. by T. Ohsumi).

Fig. 3.7 Main Dattatreya temple at Dattatreya Square (left), two watchmen / guardians hold Grakata (right) (Photo. by T. Ohsumi).

Fig. 3.8 This temple collapsed in 1934 earthquake, but has not been rebuilt (Photo. by T. Ohsumi).

3.2 Lalitpur/ Patan

In Lalitpur of the Royal Palace, Patan is “Lalitpur” in Sanskrit, is called “*Yela*” in Newari, it means the city of beauty.

The Patan palace was renovated with assistance from the Kathmandu Valley preservation trust (KVPT) and the Sumitomo Foundation in 2013.

Thus, in Patan, 2015, after the earthquake, this place had only partial damage at Gajur and Baymvah (**Fig. 3.9-10**).

Krishna Sikhara survived. Jagannarayan Temple (left), Vishnu Temple(ceter) and Narasimha Sikhara from 1598 (front) were survived (**Fig. 3.11**).

Fig. 3.10 Taleju three-tiered temple Lalitpur (Photo. by T. Ohsumi).

Fig. 3.9 Patan 2015, after the earthquake, this place had partial damage at Gajur and Baymvah (right) (Photo. by T. Ohsumi).

Krishna Sikhara

Fig. 3.11 Jagannarayan Temple (left), Vishnu Temple (ceter) and Narasimha Sikhara survived (Photo. by T. Ohsumi).

3.3 Kathmandu

The old palace structures in Kathmandu’s Durbar Square, which had no renovation, had severe damage (**Fig. 3.12**). On the left side of the white structure, which was Lana Dynasty 150 years ago. On the right side of a four-tiered brown temple, which was Gorkha Dynasty 300 years ago.

The Kasthamandap temple was built by king Laxmi Narsingha Malla in the early 16th century. The whole temple was made from a single tree (**Fig. 3.13**). Kasthamandap is said to be the etymology of Kthmandu. The earthquake on April 25, 2015 caused severe damage to this temple and it collapsed.

Westside of the Ring Road in Kathmandu, RC frame buildings were tilted. At Gongabu, northwest of Ring Road, and at Sitapatla, southwest of Ring Road, the building damage was caused by the soft ground area on the river branch (**Fig. 3.14**). At west side of the Ring Road in Kathmandu, RC frame buildings were tilted (**Fig. 3.15**). At the branch point of the Bagmati River and the Transformor River, collapsed buildings fell onto and destroyed the next building (**Fig. 3.16**).

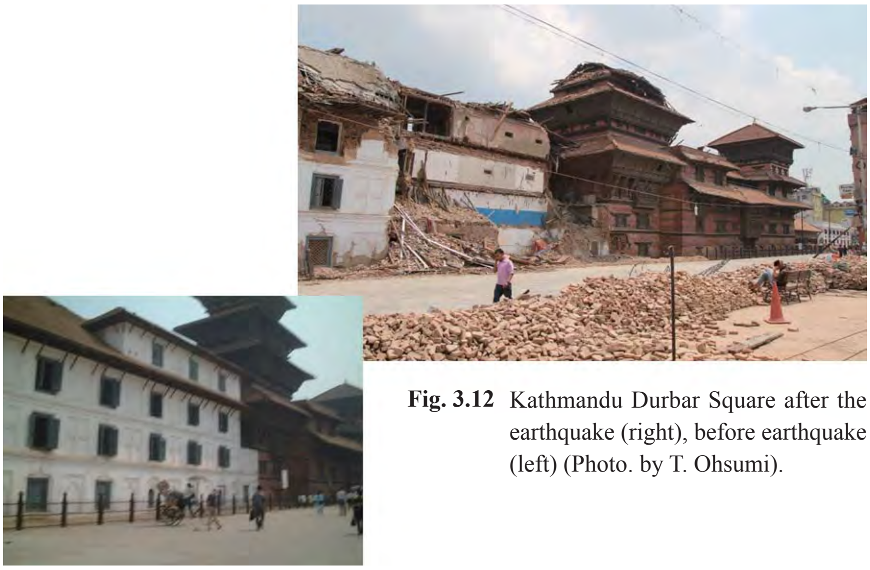
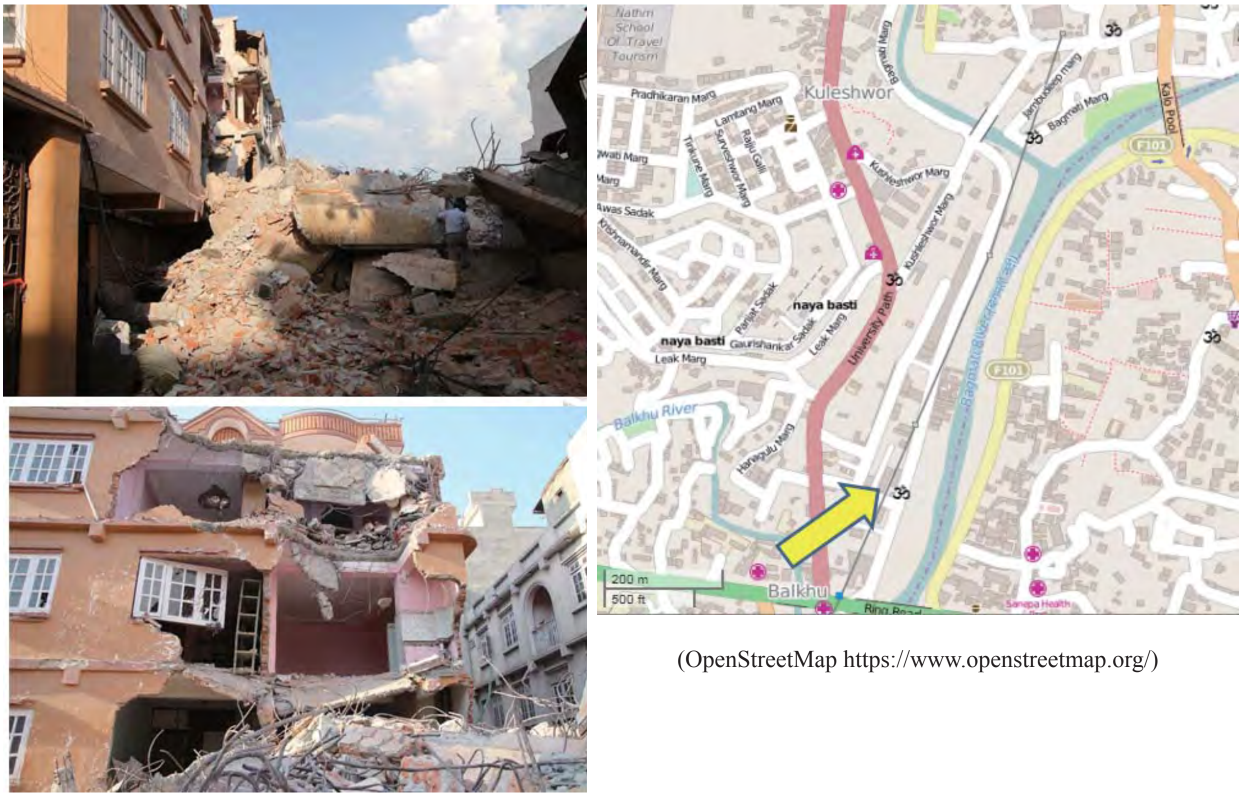


Fig. 3.12 Kathmandu Durbar Square after the earthquake (right), before earthquake (left) (Photo. by T. Ohsumi).

Fig. 3.13 Kasthamandap temple before the earthquake (*a*) / after the earthquake (*b*) (Photo. by T. Ohsumi).

Fig. 3.14 At Gongabu, RC frame buildings were tilted (*a*,*b*). A shear crack in the first flower (*c*) (Photo. by T. Ohsumi).

Fig. 3.15 At west side of the Ring Road in Kathmandu, RC frame buildings were tilted (Photo. by T. Ohsumi).



(OpenStreetMap https://www.openstreetmap.org/)

Fig. 3.16 At the branch point of the Bagmati River and the Transformor River, collapsed building fell onto and destroyed the next building (Photo. by T. Ohsumi).

3.4 Madhyapur Thimi

In JICA2002, building types were classified for the whole Katmandu. The investigation was mainly based on visual observations. In order to supplement, it was made from building inventory survey result, topographic maps and aerial photographs.

The building type classification map defined each rate of structure as 500 m×500 m mesh (**Fig. 3.17**: upper). In Sano Thimi (**Fig. 3.17**: *a*), with newer buildings, the damage has been reduced. Old Thimi located on a small hill (**Fig. 3.17**: *b*), the houses were destroyed in 1934 rebuilt and again received severe damages.

3.5 Sankhu

The houses damaged by the earthquake have been demolished with the support of the Canadian Forces in Sankhu. Heavy equipment was brought from Canada (**Fig. 3.18**). RC buildings were partially damaged the difference appears remarkable (**Fig. 3.19**). Damage in Sankhu was enormous, the brick and cement mortar houses without RC columns had a lot of damage. Structures having no RC columns on the corner, a vertical crack in a brick masonry wall was generated. Outer wall structures of buildings is baked brick with cement mortar joints to withstand rain. Inside wall of buildings is adobe bricks with mud mortar (**Fig. 3.20**).

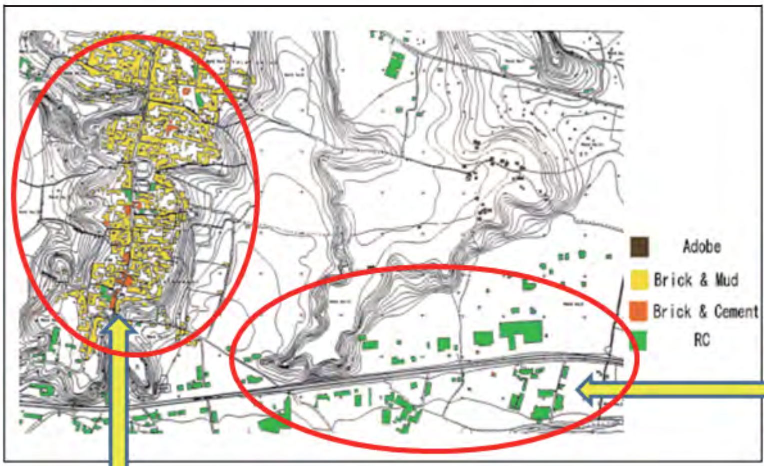


Fig. 3.17 The building type classification map in Thimi, Sano Thimi (*a*) and Old Thimi (*b*) (Photo. by T. Ohsumi).

Fig. 3.18 In Sankhu, heavy equipment from Canada (Photo. by T. Ohsumi).

Fig. 3.19 RC buildings were partially damaged, the difference appears remarkable in Sankhu (Photo. by T. Ohsumi).

Fig. 3.20 A vertical crack in a brick masonry wall was generated from the corner (*a*). Structures having no RC columns on the corner (*b*) (Photo. by T. Ohsumi).

4. Landslides, Suburbs, Rural Areas

4.1 Landslides

A numerous number of huge slope failures which occurred in the mountainous area buried villages and valleys, and resulted in the loss of many lives. We visited a landslide zone in Ramche, and it is located in the northwest of Kathmandu city in a mountainous area. Many of fallen rocks were on the roads, also we encountered a bus that hit by falling rocks (**Fig. 4.1**). Thick talus is deposited in the landslide area in Ramche, in Rasuwa district (**Fig. 4.2**). The town is located at an altitude of 2,068 m. There are houses that had been caught in a landslide, but the damage was limited. However, the whole scope of the slope failures is not clear at the present time, because any detailed and total survey in the mountainous area has not been carried out. Thus, causalities will increase as they are found.

4.2 Suburbs and Rural areas

The number of casualties is concentrated in the north-east of Kathmandu Sindhupal Chok district. We visited east Bhimeshwar (formerly Charikot), Bhimeshwar Municipality, is 50 km east of Dhulikhela. The town is located at an altitude of 1,554 m. The name of the district Dolakha came from the Dolakha Town situated north-east of the capital Charikot. These areas had many casualties. According to the local people, the aftershock felt stronger than the main shock. The aftershock's hypocenter occurred just below this area. Many houses collapsed in the aftershock.

Urban and rural housing is significantly different. In the suburban and rural areas there are many stone houses, a lot of damage occurred. The collapse of heavy stones used into house construct, took away many.

In Dolakha district, adobe style houses collapsed. First, this adobe houses collapsed at the gable and cracked at corner by ground motion. Many adobe style houses broken at gable (**Fig. 4.3**). Stone style houses also collapsed by delamination.

Stone style houses also collapsed by delamination. Stone style housing used a shaped schist as stone masonry material. Typical case of stone construction the masonry used was a mud mortar in the joints. The wall thickness was more than 50 cm. Many 2-3-story housing the floor is half-timbered. CGI sheet (galvanized wave plate) is used for roofing in half-timbered housing (**Fig. 4.4**).

Fig. 4.1 Bus was hit in falling rocks in Dhikure,on Baglung Rajmara High way (Photo. by T. Ohsumi).

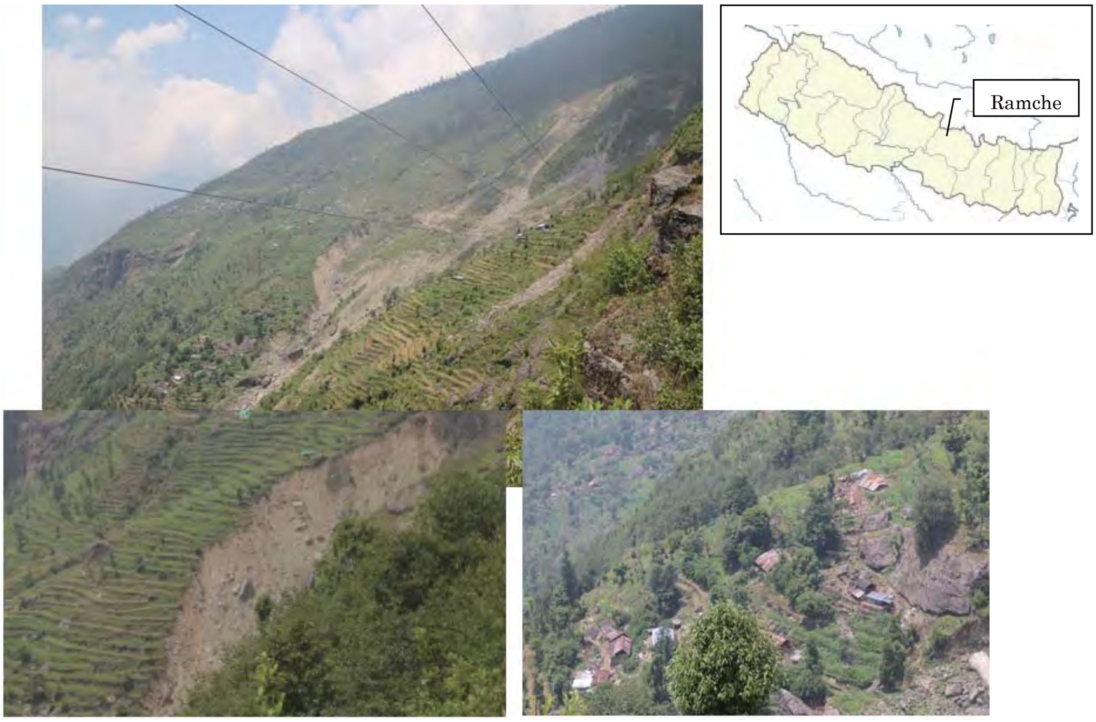


Fig. 4.2 Thick talus is deposited in the landslide area in Ramche (Photo. by T. Ohsumi).

Fig. 4.3 Adobe style houses collapsed at the gable part in Charikot, Bhimeshwor Municipality (Photo. by T. Ohsumi).

Fig. 4.4 Stone style house in Charikot, Bhimeshwor Municipality (Photo. by T. Ohsumi).

5. Discution

According to the statistics by The Nepal Police on 22 June the number of deaths 8,660 and injured 21,952 for the main shock and deaths 172 and injured 3,470 for the aftershock (**Table 1**). It was also reported that more than 5,000,000 buildings and houses were damaged and about half of those had which collapsed, number is increasing now.

Why this area had concentrated casualties?

First, this rural area's housing style is mainly stone masonry. The collapse of heavy stone took away many lives. The damaged typical housings in mountainous region, damages were concentrated in the non-engineered construction housings. In rural area, unreinforced masonry, using the material available in the region, is the main construction method. Regardless of the masonry material, serious damage of the houses were caused masonry with mud mortar. This housing construction method in urban areas, which constructed more than 30 years ago. In the rural areas, this type of housings are also currently in the people housing construction. Thus, retrofitting of low-cost housing for such non-engineers is a key issue.

A mud mortar, which is especially low adhesive strength, adhesion between the material of housing is reduce during earthquake duration time. A brittle material or structure fractures or suddenly breaks while subjected to bending, swaying, and deforming. The mud mortar avoids the brittle structure due to the little tendency to deform before it fractures.

A typical low-story part of earthquake damaged housing causes shear failure of masonry wall. Typical failure pattern of non-engineered housings are out of plane by poor bonding strength.

A stone masonry building with an RC lintel band that survived this earthquake.

According to "Guidelines for Earthquake Resistant Non-Engineered Construction" [4], horizontal bands or ring beams show detail.

The most important horizontal reinforcing is through reinforced concrete bands provided continuously through all load bearing longitudinal and transverse walls at plinth, lintel, and roof eave levels, as well as at top of gables according to requirements as stated hereunder:

1) Plinth band: This should be provided where the soil is soft or uneven in its properties as happens in hill areas. It also serves as damp proof course. This band is not too critical.
2) Lintel band: This is the most important band and is incorporated in all door and window lintels. Its reinforcement should be extra to the lintel band steel.
3) Roof band: This band is required at eaves level of pitched roofs and also below or level with suspended floors which consist of joists and flooring elements, so as to properly integrate them at ends and fix them into the walls.

Second, there are major high-frequency (1 Hz) seismic radiation exist in this earthquake waveform. **Fig. 5.4** shows earthquake rupture model for the 2015 main shock (Yagi and Okuwaki, 2015)[5]. This model inverted teleseismic P-wave data applying a novel formulation that takes into account the uncertainty of Green's function by using Yagi and Fukahata (2011)[6], which uses waveform inversion from the IRIS (Incorporated Research Institutions for Seismology)[7] waveform (time-series) data. The fault length and width of the rupture plane are east-west 150 km long, including Kathmandu and the region from north to south 120 km and 4.1 m or more.

Yagi *et al.* (2012)[8] developed a new back-projection method that uses teleseismic P-waveforms to integrate the direct P-phase with reflected phases from structural discontinuities near the source and used to estimate the spatiotemporal distribution of the seismic energy release of the 2015 Gorkha Nepal earthquake from the IRIS GSN (Global Seismographic Network) and FDSN (International Federation of Digital Seismograph Networks) Information data.

The area of major high-frequency (1 Hz) seismic radiation extended east-south-east from the hypocenter. Main slip distributes near the Kathmandu Valley. The main slip is comparatively small near hypocenter. Slip distribution by source inversion analysis is shown by contour map in **Fig. 5.4**. The area is north of the Kathmandu Valley and near North Bagmati scenario earthquake model.

The major high-frequency (1 Hz) seismic radiation area by hybrid back-projection analysis is read from Yagi's analysis and shown by pink colored square region. The area is north of Kathmandu Valley and near the North Bagmati scenario earthquake model. The major high-frequency (1 Hz) seismic radiation caused the damage to buildings and housing in the Kathmandu Valley.

Table 1 Human Damage Information by the Earthquake.by Nepal Police.

Human Damage						
Area		Death	Injured	Under treatment	Identified dead bodies	To be identified dead bodies
Arrea	KV	1,721	11,044	46	1,707	12
	Easten Region	55	323	1	55	0
	Central Region	6,425	6,348	79	6,417	2
	Western Region	457	1,100	720	457	0
	Mid-West Region	2	22	1	2	0
	Far-Western Region	-	2	-	-	0
Total		8,660	18,839	847	8,638	14

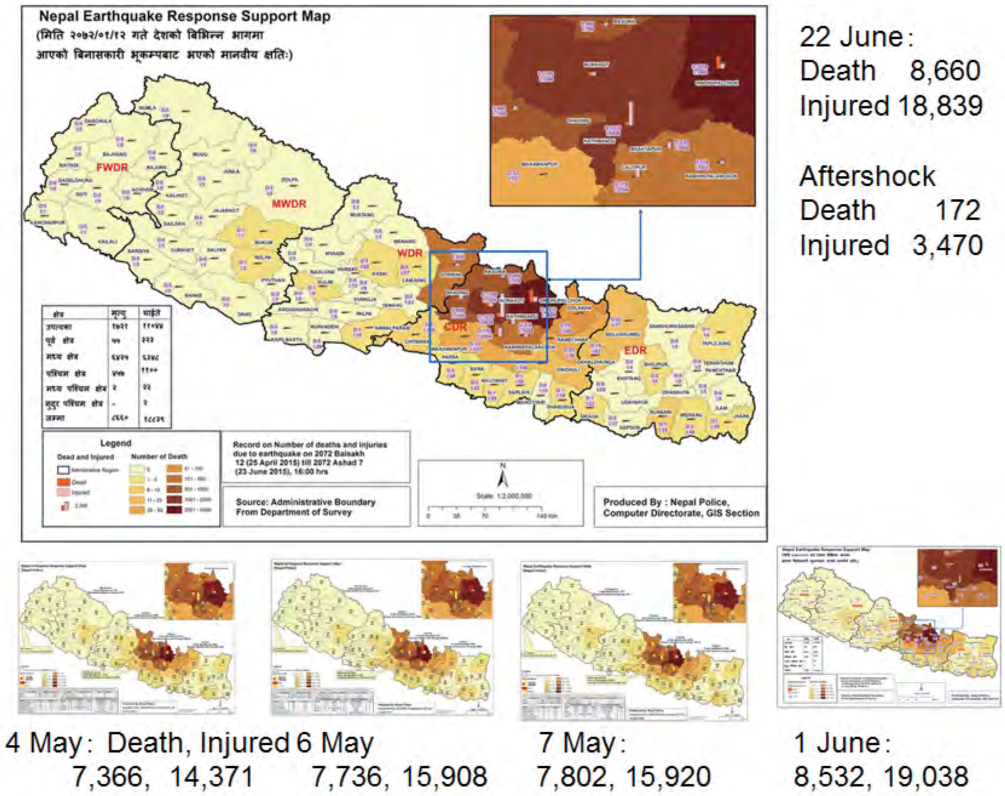


Fig. 5.1 Casualties and injured people by Nepal Police.

Fig. 5.2 Typical failure pattern of Non-engineered housings left: Nuwakot, right: Ksthmandu (Photo. by H. Imai).

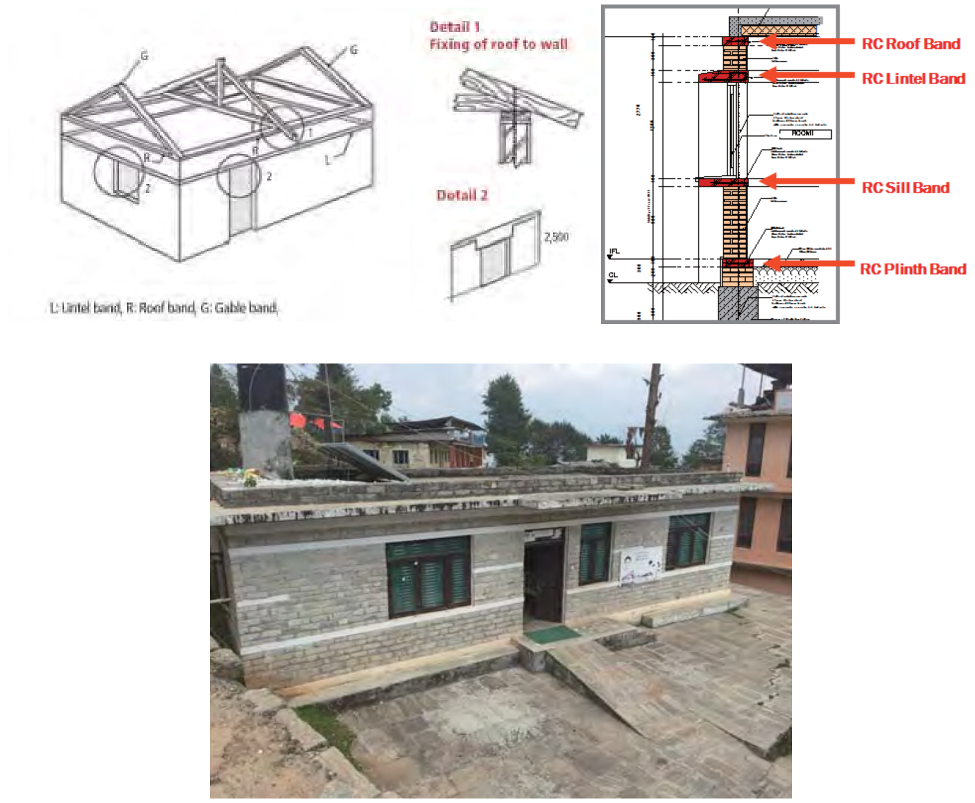


Fig. 5.3 Seismic RC band for stone and brick masonry (NSET promoted in Dolakha, Nepal) (Photo. by H. Imai) (upper figure from Arya (2013) [4]).

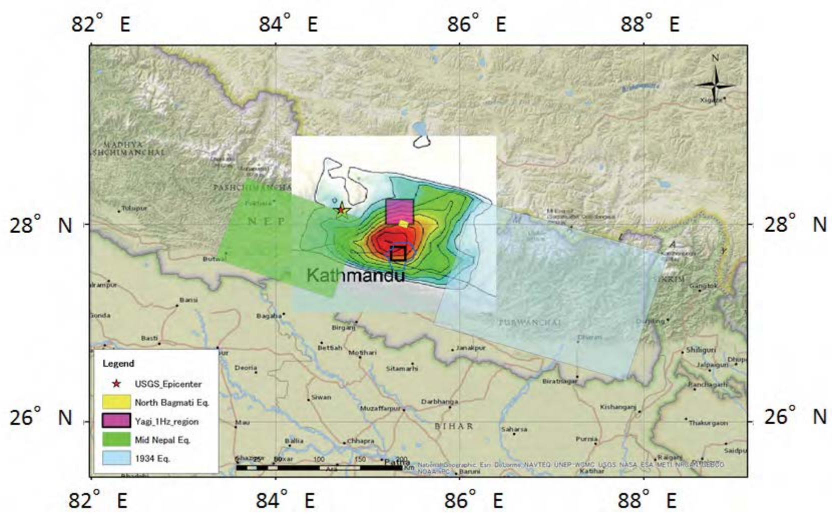


Fig. 5.4 Source Model of 2015 Gorkha Nepal Earthquake.

6. Characteristic of this Earthquake Summary and Conclusions

1) Westside of the Ring Road in Kathmandu, RC frame buildings were tilted. The building damage was caused by the soft ground area on the river branch.
2) RC buildings were partially damaged the difference appears remarkable. The brick and cement mortar houses without RC columns had a lot of damage. Structures having no RC columns on the corner, a vertical crack in a brick masonry wall was generated.
3) The number of casualties is concentrated in the north-east of Kathmandu Sindhupal Chok district. Many houses collapsed in the aftershock. Urban and rural housing is significantly different. In the suburban and rural areas there are many stone houses, a lot of damage occurred. The collapse of heavy stones used into house construct, took away many.
4) Three kings in the Kathmandu valley palaces were in Kathmandu, Bhaktapur, and Lalitpur / Patan. The difference between the renovation works done at these palaces was significant (Not for the historic structures of the old royal palace).
5) In the rural areas, stone masonry type of housings are also currently in the people housing construction. Thus, retrofitting of low-cost housing for such non-engineers is a key issue.
6) The major high-frequency (1 Hz) seismic radiation caused the damage to buildings and housing in the north of Kathmandu Valley.

Nepal and Japan has a long history of cooperation in earthquake engineering and many joint research projects have been carried out in the academic field for earthquake disaster mitigation.

2016 is the 60th anniversary of the established of Nepalese and Japanese diplomatic relations. All of the members of the NIED team wish to strengthen our partnership in earthquake engineering between Nepal and Japan through the cooperation for the investigation into this earthquake disaster and through future joint research projects.

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2015 年 4 月ネパール地震 (Gorkha 地震) における
建物被害に関する情報収集調査速報

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要　旨

2015 年 4 月 25 日 11 時 56 分 (現地時間)，ネパール中北部を震源域とするマグニチュード (M_w) 7.8 の地震が発生し，首都カトマンズを中心とする広い領域で，主としてレンガ組積造建物が倒壊による多くの被害が発生した．この報告書は，5 月 26 日から 6 月 3 日にかけてカトマンズ盆地を中心にデータ収集として，調査団を派遣し，その調査速報である．この 1 次調査の目的は，かねてより進めている地震ハザード・リスク評価，地震被害推定手法の研究として，現地の煉瓦組積造及び石造りの建物調査を実施した．また，防災科研が進めている衛星データからの被害想定のためのクランド・ツルースの利活用に関する研究の成果を活用し，今後の詳細建物調査につなげるものである．地震によって倒壊した建物，被害を受けなかった建物調査を行い，ネパール国の今回の地震からの復旧・復興ならびに将来の地震災害軽減に資するため現地調査および情報収集を行った．

キーワード：コルカ・ネパール地震，カトマンズ，煉瓦組積造，石造り，グランド・ツルース