Final Report on
Building Inventory, Damage and Seismic Intensity Survey for the JICA Aided the Project for Assessment of Earthquake Disaster Risk for the Kathmandu Valley in Nepal

Ref. No. R7011/JICA/015

Prepared by:

National Society for Earthquake Technology-Nepal (NSET)
Karyabinayak Municipality, Ward No. 2
Bhainsepati Residential Area, Lalitpur
P.O. Box: 13775, Kathmandu, Nepal
Telephone: (977-1) 5591000
Fax: (977-1) 5592692
Website: www.nset.org.np

Submitted to:

JICA Project Team
Oriental Consultants Global Co. Ltd.; and
OYO International Corporation JV
JICA Supported Programme
Hotel Ghangri,
Boudha Road,
Kathmandu, Nepal

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FOREWORD

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LIST OF ABBREVIATIONS

ATM	Anantalingeshwore Municipality
BCM	Brick in Cement Mortar
BJB	Bajrabarahi Municipality
BMM	Brick in Mud Mortar
CDM	Chandragiri Municipality
CGI	Corrugated galvanized iron sheet
CNG	Changunarayan Municipality
DKM	Daxinkali Municipality
DUDBC	Department of Urban Development and Buildings Construction
GDM	Godawari Municipality
GKM	Gokharneshwor Municipality
GIS	Geographic Information System
JICA	Japan International Cooperation Agency
JPT	JICA Project Team
KMM	Kageshwori Manohara Municipality
KV	Kathmandu Valley
LSMC	Lalitpur Sub-Metropolitan City
MLM	Mahalaxmi Municipality
MMI	Modified Mercalli Intensity
MSM	Mahamanjushree Municipality
MTM	Madhyapur Thimi Municipality
MoUD	Ministry of Urban Development
MUN	Municipality
NJM	Nagarjun Municipality
NSET	National Society for Earthquake Technology – Nepal (NSET)
PIT	Project Implementation Team
RCFrame (Eng)	RC Frame Engineered
RCFrame (noneng)	RCFrame Non Engineered
SBM	Suyabinayak Municipality
SCM	Stone in Cement Mortar
SKM	Shankharapur Municipality
SMM	Stone in Mud Mortar
TKM	Tokha Municipality
TOR	Term of Reference
TSM	Tarkeshwor Municipality
UNDP	United Nation Development Program

1 INTRODUCTION

1.1 BACKGROUND

This document is the Final Report prepared submitted by the National Society for Earthquake Technology – Nepal (NSET) to Oriental Consultants Global Co. Ltd. and OYO Corporation JV under the agreement between OYO and NSET jointly with GeoSpatial Systems Pvt. Ltd. This report includes general background of the survey, aims/objectives, methodology of the survey, and summary results of the survey. The survey was carried out in context of post-earthquake building damage and seismic survey in highly affected areas of 2015 Gorkha Nepal Earthquake.

The April 25th 2015 Gorkha Earthquake in Nepal caused 8,450 deaths and more than 750,000 buildings severely damaged with significant of them got collapsed. It is estimated that the lives of eight million people, almost one-third of the population of Nepal, have been impacted by these earthquakes. Thirty-one of the country's 75 districts have been affected, out of which 14 were declared 'crisis-hit' for the purpose of prioritizing rescue and relief operations; another 17 neighboring districts are partially affected. After the earthquake, many organizations carried out assessments of the buildings and suggested people whether the buildings are safe or unsafe for use together with assessments for the future planning for disaster risk reduction.

The destruction was widespread covering residential and government buildings, heritage sites, schools and health posts, rural roads, bridges, water supply systems, agricultural land, trekking routes, hydropower plants and sports facilities etc. In addition to this hundreds of historical and cultural monuments at least a century old were either destroyed or extensively damaged.

However, the information on possibility of repair/retrofit or demolition was not covered to all buildings partial or completely destroyed/damaged because of the earthquake yet. So, detail damage assessment of the building was necessary so that reasonable suggestions can be provided to future planning. Further, the local governments can use the detail damage assessment information for the development of reconstruction strategy within their jurisdiction. In addition, the detail damage assessment help to understand the main reason of damage to buildings and the lessons learned will be beneficial for designing future strategies for disaster risk reduction.

The main objective of the program was to carry out building inventory, damage assessment of respective buildings in Lalitpur Sub-Metropolitan City (LSMC), Bhaktapur Municipality all buildings, and other municipalities in Kathmandu Valley in sample basis, outside the KV, sample basis in severely damage 14 districts.

This report covers the part of NSET, whereas the report of LSMC survey under Activity 1 has been submitted in separate volume by GeoSpatial Systems Pvt. Ltd in separate volume.

1.2 AIMS AND OBJECTIVES

The aim of the project was to contribute for systematic process of collection of building damage information in selected regions (areas of survey, municipalities) of the earthquake severely affected districts/ municipalities due to the 2015 Nepal Gorkha Earthquake and subsequent aftershocks. The overall objective of project was to prepare GIS based building inventory data with structural characteristics of existing buildings; damage data of existing buildings; and carry out seismic intensity survey.

The specific objectives to achieve the above goal were to –

- Prepare inventory of all buildings in Lalitpur Sub-Metropolitan City (LSMC) and Bhaktapur Municipalities;
- Conduct damage assessment for all buildings as inventory made for these municipalities;

- Assess and collect building information in selected municipalities on sample basis as defined based on scope of the work;
- Prepare detail database of each building in GIS system;
- Prepare loss curve as per the requirement of project; and
- Carryout seismic intensity survey in selected locations of municipalities' together with where building survey has been conducted.

1.3 PROJECT LOCATION

The project area was defined as follows:

1. Lalitpur Sub-Metropolitan City (LSMC), and Bhaktapur Municipality;
2. Kathmandu Valley (KV) 19 Municipalities on sample locations;
3. Out-side KV focused on highly affected areas of 2015 Gorkha Earthquake in the areas of relatively higher intensities.

For the detail of the project area refer Map 4-1.

1.4 PROJECT INFORMATION

The project information is presented in following table in brief.

Table 1-1: Project Information Sheet

<table>
<tr><td colspan="2">Project Name</td><td>Primary Sector:</td></tr>
<tr><td colspan="2">Building Inventory, Damage and Seismic Intensity Survey</td><td></td></tr>
<tr><td colspan="3">Secondary Sub-Sector(s) and Cross-Cutting Themes(s)</td></tr>
<tr><td colspan="3">Inventory, Damage Assessment, Intensity, Disaster Risk Reduction</td></tr>
<tr><td colspan="2">Country/Countries of implementation:</td><td>Regions of Survey</td></tr>
<tr><td colspan="2">Nepal</td><td>• Kathmandu Valley, and
• Highly Affected Districts/Municipalities of 2015 Nepal Gorkha Earthquake</td></tr>
<tr><td colspan="2">Project Contact & E-mail Address:</td><td>Total Budget Amount</td></tr>
<tr><td colspan="2">Ramesh Guragain (rguragain@nset.org.np), NSET-Nepal
Gopi Krishna Basyal (gbasyal@nset.org.np), NSET-Nepal
Suresh Shrestha (ssuresh@geosp.com), GeoSpatial Systems Pvt. Ltd. (Geo)
Akira Inoue (inoue@oyointer.com), JICA Project Team (JPT)</td><td rowspan="3"></td></tr>
<tr><td>Project Start Date</td><td>Project End Date:</td></tr>
<tr><td>September 15, 2015</td><td>February 29, 2016</td></tr>
<tr><td colspan="2">Major Partner(s)/Donor(s)</td><td>Role(s)/ Contribution:</td></tr>
<tr><td colspan="2">Donor: JICA Aided Project
Consultant: JICA Project Team; Oriental Consultants Global Co. Ltd., and OYO International Corporation JV. Kathmandu Nepal
Sub-Consultant: National Society or Earthquake Technology (NSET), jointly with GeoSpatial Systems Pvt. Ltd. (Geo).</td><td>Number of building surveyed @ 27,000; Number of intensity questionnaire survey @ 125 locations</td></tr>
<tr><td colspan="3">Project Summary</td></tr>
<tr><td colspan="3">Building Inventory, Damage and Seismic Intensity Survey for this project designed and carried. The survey was conducted in Lalitpur and Bhaktapur Municipalities for 100% buildings, where other municipalities in KV was carried out on sample basis. Outside Kathmandu Valley, sample municipalities were chosen for survey and survey was conducted again sample basis. Intensity survey was done along with the building damage survey. The results have been prepared and submitted to OYO.</td></tr>
</table>

2 APPROACH AND METHODS

2.1 MAIN APPROACH AND SCOPE OF THE SURVEY

2.1.1 APPROACH

Following approach has been taken in consideration during implementation of the project:

- The project scope was wide and varied as given in limited time for implementation. Keeping this in mind implementation of the different tasks within the project period of 5 months will take place requiring extensive facilitation and efficient coordination;
- Primary data gathering is minimal;
- A project implementation team (PIT) and the formation of technical working groups (TWG-focused groups) involving program implementation partners and relevant stakeholders will be very helpful in organizing the schedules, providing guidance and making decisions;
- The current work was basically field survey; field coordination, data management, preparatory works for the survey is crucial.

2.1.2 SCOPE OF THE WORK

Based on Term of Reference (ToR), the tasks were as follows:

1. Whereas total buildings to be surveyed in two municipalities of Kathmandu Valley of approximately 50,000 buildings in Lalitpur and Bhaktapur Municipalities. NSET was carrying out one of them in Bhaktapur Municipality having approximately 15,000 buildings.
2. Sample building survey of approximately 10,000 building survey at 19 Municipalities of Kathmandu Valley,
3. Sample building survey (approximately 1,000 buildings out of Kathmandu Valley; and
4. Seismic Intensity Questionnaire Survey in the same localities together with Building Survey activities.

For the detail of the project area refer Map 4-1.

2.2 METHODOLOGY OF THE SURVEY

The methodology adopted on this project are as follows:

- Preparation for the field survey – all necessary preparation including software, structure of the survey concept, human resource management, training of surveyors, work plan preparation, maps and field papers preparation, collection of necessary images from different sources included JICA etc (JPT), collection of other secondary information from different sources i.e. municipalities and other data sources.
- Develop Questionnaires – The initial part of the project was agreement on the final questionnaire as per the project requirement. This was used as provided by JICA Project Team (JPT). The digital version of the questionnaire was transferred to the Android application. Intensity survey questionnaire was used in paper format.
- Selection and Training of Surveyor – While selecting surveyors, a call was made. Training curricula was adopted and modified from the similar project as carried out by NSET, which originally was developed to enhance the technical and social knowledge and skills of surveyor for assessment of building. This includes, technical as well as social issues to be taken into consideration while conducting the survey.

- Use of IT Tools for Survey – Android application was developed and used for collection for data. The server was established in two places (Geo and NSET) for the convenient of work efficiency. The collected data from the field were uploaded on central web server in daily basis.
- Documentation, mapping GIS Data, softcopy preparation – this includes preparing point map (as a preparatory work for pre-field work and during field work too), preparation of attributed of the buildings, joining spatial and non-spatial data, check discrepancies, and making final database in shape format.
- Surveyor Mobilization Plan – Surveyor mobilization plan developed for "Earthquake Risk Perception Survey" under the Building Code Implementation Program on 24 municipalities was revised for this assessment. Fresh graduate civil engineers with essence of volunteerism were targeted for the assessment team.
- Use of Software for Data Management and Reporting – Develop software or web application to upload, store and analyze data spatially as per data collection. The open source GIS QGIS was used for the data management in GIS.
- Execution of the field survey – this includes field survey by surveyors, visual observation, recording of information on both paper and android devices including photographs as per the field survey form accordingly,
- Post processing of the data was carried out in as desk based. Summarize data and preparation of the reports.

The activity wise detail of methodology is described in Chapter 3.

3 ACTIVITIES

Based on scope of the work and the approach above mentioned, the following activities were carried out during execution of the project.

3.1 FORMATION OF PROJECT TEAM

After signing of contract, the project team has formed accordingly and submitted to JPT with the detail of assignments and responsibilities (see Annex I).

3.2 CONSULTATION WITH MUNICIPALITIES

Project introduction and other consultation meetings were organized with municipalities by JICA Project Team (JPT) in Lalitpur Sub-Metropolitan City (LSMC) and Bhaktapur Municipalities in initial part of the project. Follow-up consultation were done on need basis by project implementation team.

3.3 QUESTIONNAIRE FOR DETAIL DAMAGE ASSESSMENT

The survey was carried out based on questionnaire survey, form is presented on the Annex II. Questions used to survey of buildings were taken from the ToR. The finalization of questions were done after series of consultation with JPT.

3.4 SELECTION OF SURVEY SITES

Survey sites/locations were selected as decided on proposal and subsequently by consultation with JPT on the current situation during the time of survey. LSMC and Bhaktapur Municipality were chosen for 100% of the building survey. While other 19 Municipalities in Kathmandu Valley (KV) were chosen for the sample survey. Municipalities outside the Kathmandu valley were chosen for sample survey in relatively higher intensity areas of 2015 Gorkha Earthquake.

The sample size of buildings for survey, each municipality in KV were selected for some 500 buildings in each municipality. Outside KV Municipality each municipality has about 200 buildings surveyed.

3.4.1 DATA PREPARATION AND FIELD PAPERS

The following process were done while preparing pre-field data and field papers.

- Pre-digitization of building points for LSMC (the separate report) and Bhaktapur Municipality (total of 15000, building points) were pre-digitized before the field survey from high-resolution satellite images provided by JPT for the project reference.
- With the points overlaying on images, field papers were prepared and printed for surveyors' reference, to be checked in the field.
- In areas, where high-resolution images were not available (other than Bhaktapur Municipality), Google Earth images of different dates (as available for free) were taken in consideration to make field papers.
- 200 meter *200 meter grid lines were formed in GIS format, overplayed on Google Earth as KML file, selected sites were printed in A4 paper in reasonable scale for field work. These grids were assumed to be sufficient for the relatively low building density areas, especially outskirts of the Municipalities, and outside the KV Municipalities.
- In the areas where 200 meter *200 meter grids were not sufficient for the core areas of Municipalities were further enlarged while preparing printed field papers.

3.4.2 DEVELOPMENT OF ANDROID APPLICATION

A customized database management android application was developed for entry of surveyed data from the field together with uploading to the webserver (see section 3.4.3) located at GeoSpatial Systems, and in NSET. For each inventory of building with filled up survey form (in android device) uploaded to the server on daily basis as possible. The application has the facility of directly uploading these information to the server. As off-line mode, the data saved in device can directly be uploaded to the computer, was also done in case of difficulty in internet availability.

Some of the features of the application has:

- Capability of entering data, saving and displaying saved data, and edit data, when necessary;
- Ability to identify Code mismatch and duplicates, it helps in maintaining uniqueness of each data;
- Easy-to use user interface and design, the user does not need to have special skills and qualification for using it. Basic computer knowledge is enough for understanding the application.
- Facility of working off-line mode while data collection, upload later.
- Facility of taking picture of the surveyed building, and upload together with other information to the server or directly into the computer.

3.4.3 SETTING SERVER

To upload data from different devices of surveyors, as well as data depository purpose, two separate server systems were established at GeoSpatial and NSET, and there by the data were uploaded and deposited accordingly in both systems. GeoSpatial server system was used for data management for LSMC and NSET server system was used for remaining part of the work.

3.5 SELECTION OF SURVEYORS

The open call was made based on different criteria. Following general criteria were taken in consideration while selecting surveyors/volunteers:

- Must be an engineering graduate, with interest in volunteering, visiting as assigned.
- Direct approach through for Bhaktapur Municipality for conducting survey in Bhaktapur Municipality. This strategy was taken because of mobilizing local resources for more convenient as well as good access to the local community for data collection.
- The second approach was volunteers were called through online application form. The applicants were short-listed based on criteria.
- The selected applicants were called one or two day prior to training to brief training and assessment objectives, methodology, time schedule, assessment area and logistic system as well as briefly interviewed to know in person about their level of enthusiasm, interest, attitude and availability of time. The selected applicants were requested to sign up for training.

Based on these approach, volunteers were selected for the training purpose.

3.5.1 TRAINING OF SURVEYORS

The main objective of training was to enhance the knowledge and skills of surveyors/volunteers to carry out building inventory and damage assessment. The intended target group of the course

were civil engineers. The training course was designed for one day interactive lectures and one day guided survey on field.

The training course focused on interactive lectures as well as exercises and demonstration. Trainees were open to share their practical experiences with each other and also with the trainer. The training delivery was in the form of power point presentation through multimedia projection system. Major part of this training used Nepalese guidelines on post-earthquake damage assessment DUDBC/NSET/UNDP; as per the requirement of the present survey work specification.

There were series of training conducted as per the need of surveyors. The first training was carried out for first lot of the surveyors from Geo., the survey to be conducted in LSMC.

A total of 48 participants/surveyors/ volunteers were trained on two different trainings held at NSET on 6-8 October 2015.

The second training was conducted for the participants focused for Bhaktapur Municipality survey engineers. Total of 44 participants were participating in this training. Two of Governmental Officers were also participating for the training.

The third training was conducted for remaining volunteers who were mobilized in KV and outside KV region mobilization.

The training details are presented in Annex IV. Detail list of participant is listed in Annex VII.

3.5.2 AGREEMENT

After the training, participants were requested to sign-up for the field work. The formal contract/agreement between surveyors and NSET was signed for detailing of work assignment, time, remuneration and other expenses etc.

3.6 METHODOLOGY OF DATA COLLECTION

There were three approaches were applied for data collection from each building. They are:

- Inventory – preliminary inventory was made before going to the field. This was done because of tentative estimation of the building in survey site. For Bhaktapur Municipality, pre-digitized building points were created. For remaining regions (of survey sites) total number of buildings were estimated using Google Earth there by field papers were prepared.
- Field observation – team of surveyors then carried out survey by visiting each building. One team of surveyors (two people) were mobilized for one region (of ward, or mapping unit or neighborhood) where team of surveyors could have better decision, especially for difficulties in identifying the building typology.
- Interview – however, the survey was not focused on interview of the building owner/informant, the focus was by observing by surveyors' decision. Where nee, surveyors take interview for some of attributes/information such as year of the construction of building and etc. were taken from building owners/occupants.
- Photographs – at least two digital photographs were taken for the each building, one for overall external overview of the building, and another was focusing particular section/portion of damage. This photograph has also unique identification number (unique ID) for the corresponding building ID. These two identification numbers were used during report generation. These photographs are interlinked with unique ID of the building correspondence to its latitude & longitude.

3.7 MOBILIZATION OF SURVEYORS AND COLLECTION OF DATA

Trained surveyors were mobilized in Bhaktapur Municipality, 19 Municipalities in KV and outside KV for the survey. Surveyor mobilization duration is presented in Table 3-1 below.

Table 3-1: Survey area, Implementation Information Sheet

S.N	Survey area	Survey duration	Remarks
1	Lalitpur Sub-Metropolitan City (LSMC)	-	By Geo, reported in separate volume
2	Bhaktapur Municiaplity	October – December, 2015	
3	Kathmandu Valley (KV) Municipalities	November 2015– January, 2016	19 Municipalities sample, Except LSMC, Bhaktapur
4	Outside KV, Municipalities	January – February 2016.	Outside KV Municipalities

3.7.1 DATA UPLOAD

Survey data ware uploaded to the server at NSET in daily basis as possible as per surveyor's convenience and availability of the internet. In case of difficulties in uploading data to the server were directly downloaded to the computer and made uploaded to the server by the project team at NSET.

3.7.2 DIGITIZATION OF SURVEY BUILDING LOCATION

All information collection were used in field paper for all buildings surveyed. All surveyed buildings were marked in map (field paper) and then digitized in Google Earth. KML files (in Google Earth) were created in first step, then the data was processed and exported to the GIS environment. Simple join process (spatial data and building information) was performed with all attributes collected from the field and information stored in webserver.

After filling building identifier number, which is a unique number for each building, filling in the field paper, the building point was digitized in the computer accordingly.

3.7.3 FINALIZATION OF DATA

The following process was conducted while finalizing data:

- The data from field survey – the building information was directly uploaded form mobile devices to the server and stored over there;
- Data download from the server to local computer, in MS Excel format;
- Checking mis-match, duplication etc, clean-up of data;
- Joining attribute data to spatial data with unique ID in GIS platform.

3.8 PREPARATION OF DOCUMENTS, GIS CLASSIFICATION MAPS WITH POINT DATA

Along with this Final Report, there were regular interval weekly and bi-weekly reports were prepared and submitted to JPT. GIS Classification maps were generated and submitted. The maps are submitted in PDF format. The point data prepared as building inventory are also submitted.

The following section has mentioned about the final data submitted in different form of deliverables.

3.9 OUTPUTS AND FINAL DELIVERABLES

The following deliverables are submitted as per the project requirement. Description of each deliverables are described as following:

A: Surveyed Sheets in PDF Format

Filling Survey Sheet contains following attributes

GIS datasets are populated and updated with associated existing attributes each building. Associated attribute data as collected and updated from the field survey and field verification works were prepared in SHAPE file format.

Total of 12 type of information covers for each building are presented in Annex II.

For intensity survey attributes collected from each respondent is presented in Annex V (presented in English and Nepali Languages.

B: GIS data and printed maps

GIS layers of the building point maps are submitted along with this report to the JPT team in SHAPE file format. PDF maps for sample of the output are submitted together with the report.

C. GIS Classification Map

GIS classification maps are submitted along with this report. Classification maps are prepared with structural types, damage ratio, evaluated seismic intensity.

D. Final Report

Till the end of project, the weekly, bi-weekly and Progress Reports were submitted as per the progress made so far.

This Final Report has been submitted as per the contract and project delivery, after comments received from the JPT with the correction made incorporating suggestion.

3.10 LIMITATIONS

While implementing the project, following major limitations and challenges were faced:

- For sample survey for Kathmandu valley, each municipality was surveyed approximately 500 buildings. In this case the sample size taken for the study may not entirely represent the damage grade or percentage for the proportional interpolation of the result.
- For the survey in municipalities of outside the KV selected were also in sample basis. Only 200 buildings in survey municipalities may not represent for the entire municipality for the same earthquake damage scenario.
- Selecting process of region for the sample survey was based on road-access.
- The situation aroused in the country during the project implementation period especially power shortage and severe fuel crisis hindered project in mobilizing surveyors in the field.

3.10.1 QUESTIONNAIRE FOR DETAIL DAMAGE ASSESSMENT

The questionnaire was used as per the project requirement. However there could be other attributes also added for the detail survey of each building. Other attributes such as owner's name, supports from the government etc. have not been included in the survey.

3.10.2 SELECTING SURVEYORS

- For survey in Bhaktapur municipality, engineers/volunteers form Bhaktapur Municipality were chosen with consultation with Municipality, for easy access and convenient for the surveys for transportation and local language knowledge, access to the communities.

- Survey in KV, were invited for the interested of the trainers visiting Municipalities of KV and willingness to go outside KV.

3.10.3 Training Surveyors

One day formal training and one day field training was carried out for their understanding. The survey was based on the surveyor's understanding of the each building and their report. For the cross check and verified, field supervisors were mobilized.

3.10.4 Mobilization of Surveyors

There was difficulties during the project execution, especially for the current situation of the country. Frequent power cut, which hampered in total working hours of project staffs as well as uploading data through internet by surveyors. Fuel crisis also hampered to the time of survey, in difficulties in mobilization of surveyors on time. Daily movement of surveyors also hampered for total working hours of surveyors. Majority of time spent for travel. Price hike of vehicles.

3.10.5 Data Collection

The field survey of damage buildings were based on field examination from outer side of structure only. For demolished building; attribute like-structure type, typology and footprints were collected based on consultation with adjacent locality. Photographs were considered only from front side in the case of row house buildings. Construction year and structure type were analyzed based on surveyors' experience and view. There was problem taking Photographs of buildings which was located on narrow alley. Building information of restricted area like army barracks, army school, police barracks were not included in the survey. Apart from this, building inside the Bhaktapur Industrial area and Building of Some Private villa were not included in the report as they restrict the survey.

4 SUMMARY OF DATA AND RESULTS

This section presents overall summary of survey data. Activity wise details results are presented in the following sub-sections.

Two fundamental methods were prepared for data analysis.

- First was to develop information about the buildings surveyed (building inventory) in different regions by their location as well as attributes collected;
- Second was to prepare spatial-information of the data i.e. preparation of GIS database, prepare maps, summarize according to the region, and make graphical and other representation of the data;
- Third step was to prepare summary of data, and present in different statistical forms;
- Fourth step was taken as spatial data processing, preparation of maps and other post processing activities.

In summary, under Activity 1, all buildings in LSMC and Bhaktapur Municipalities were surveyed. For rest of municipalities in KV (under Activity 2) were selected for sample survey, by selecting approximately 500 buildings in each municipalities. Some of the municipalities in KV were not surveyed with consultation with JPT, assuming that the surveys were conducted by other projects with the possibility of data exchange. These were Budhanilkantha Municipality, Kathmandu Metropolitan City (KMC), and Karyabinayak Municipality.

The sample municipalities outside KV (for Activity 3) were also selected in consultation with JPT, targeting with relatively higher intensity of 2015 Gorkha Earthquake municipalities.

For Intensity Survey (Activity 4), all the location visited by surveyors were taken into consideration, where some locations were selected. In some of municipalities, only intensity survey was carried out.

The total number of building survey (under activity 1, 2 and 3) was 26,616. Sample municipalities, number of buildings surveyed by municipalities are presented in Table 4-1 below. The detail of settlement wise location of building survey for municipalities in KV or outside KV is presented in Table 4-16 in section 4.5.

Table 4-1: Total Number of Sample Buildings Surveyed by Municipalities, in and outside the Kathmandu Valley

SN	Municipality	# of Buildings surveyed	Location	Remarks
1	Anantalingeshwore	558	KV	Damage and Intensity
2	Chandragiri	1,067	KV	Damage and Intensity
3	Changunarayan	718	KV	Damage and Intensity
4	Bajrabarahi	619	KV	Damage and Intensity
5	Daxinkali	261	KV	Damage and Intensity
6	Godawari	768	KV	Damage and Intensity
7	Gokharneshwor	816	KV	Damage and Intensity
8	Kageshwori Manohara	1,031	KV	Damage and Intensity
9	Mahalaxmi	633	KV	Damage and Intensity
10	Mahamanjushree	549	KV	Damage and Intensity
11	Nagarjun	499	KV	Damage and Intensity
12	Shankharapur	483	KV	Damage and Intensity

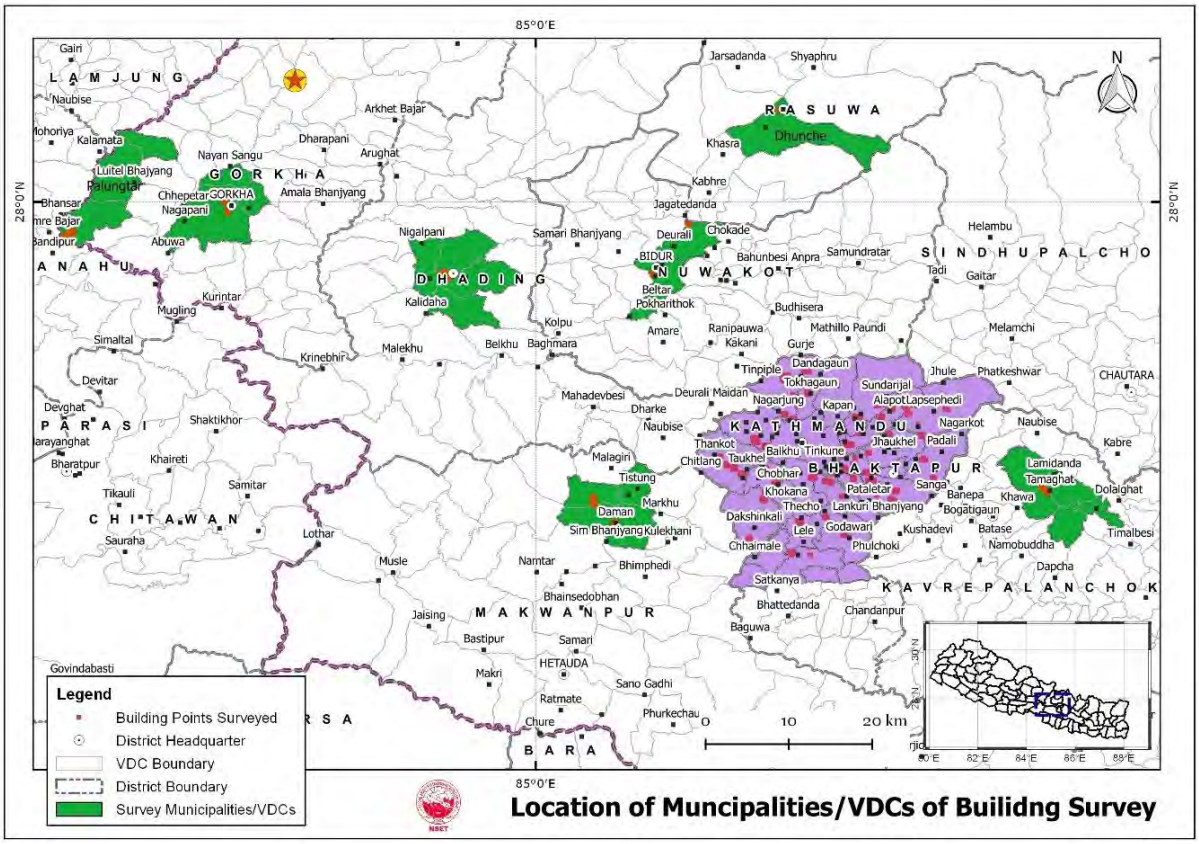
SN	Municipality	# of Buildings surveyed	Location	Remarks
13	Suyabinayak	795	KV	Damage and Intensity
14	Tarkeshwor	588	KV	Damage and Intensity
15	Tokha	458	KV	Damage and Intensity
16	Kirtipur	690	KV	Damage and Intensity
17	Madhyapur Thimi	548	KV	Damage and Intensity
	Total in KV	**11025**		
19	Bhaktapur	13485	KV	bulk damage @ 300, Damage and Intensity
20	Lalitpur			Geospatial Work
	Total Bhaktapur Muni.	**13485**		
21	Palungtar	173	Gorkha	Damage and Intensity
22	Gorkha	183	Gorkha	Damage and Intensity
23	Bidur	149	Nuwakot	Damage and Intensity
24	Nilkantha	175	Dhading	Damage and Intensity
25	Thaha	110	Makawan.	Damage and Intensity
26	Panchkhal	317	Kavre	Damage and Intensity
27	Betrawati	118	Rasuwa	Damage and Intensity
28	Dhunche	209	Rasuwa	Damage and Intensity
	Total (outside KV)	**1,434**		
	Grand Total	**25,959**		

The overall result of survey has been summarized/presented in Table 4-2 as following for activities 1, activity 2 and activity 3.

Table 4-2: Summary of the Survey Results

	Municipalities (Region of Survey		
	Bhaktapur	**KV Municipalities**	**Outside KV Municipalities**
Number of Buildings Surveyed	13485	11025	1,434
Major **Structural Types**	% distribution		
Adobe	0.98	6.4	1.6
Stone with Mud Mortar	0.27	4.5	36
Stone with Cement Mortar	0.30	0.7	6.7
Brick with Mud Mortar	48	19	13
Brick with Cement Mortar	13	20	13
RC Frame Non-Engineered	24	42	27
RC Frame Engineered	12	5	2.0
Other Steel Wooden Frame	1	2.4	1.1
Damage Grade	% distribution		
Grade 1	57	73	9
Grade 2	14	10	22
Grade 3	12	6	17
Grade 4	10	5	14
Grade 5	7	6	8

The following Map 4-1 shows the distribution of location of survey in overall and in Kathmandu Valley and other Municipalities surveyed.



Map 4-1: Location map of Survey Area.

The major findings of each of activities are presented in following sub-sections.

ACTIVITY 1: BUILDING SURVEY IN BHAKTAPUR MUNICIPALITY

The scope of work for Activity 1 was specified as the survey of all existing buildings of Lalitpur Sub-Metropolitan City (LSMC, which was carried out by GeoSpatial and the report has been submitted in separate volume by Geo) and Bhaktapur Municipality where about 15,000 buildings were surveyed by NSET under this activity.

The following paragraphs will describe summary of survey results in Bhaktapur Municipality.

4.1 NUMBER OF BUILDINGS SURVEYED

Total number of buildings surveyed in Bhaktapur Municipality were 13485. The following table (Table 4-3) shows ward-wise distribution of buildings surveyed in Bhaktapur Municipality.

Table 4-3: Ward-wise Number of Buildings Surveyed in Bhaktapur Municipality.

Ward Number	Total	Ward Number	Total
1	973	10	729
2	1052	11	562
3	581	12	497
4	2111	13	336
5	917	14	767
6	517	15	966
7	771	16	523
8	529	17	1338
9	316	**Total**	**13485**

The above table excludes the buildings with CGI sheet which were constructed as temporary shelters after the earthquake. Following Figure 4-1 shows ward-wise percentage distribution of total number of buildings surveyed in the Municipality.

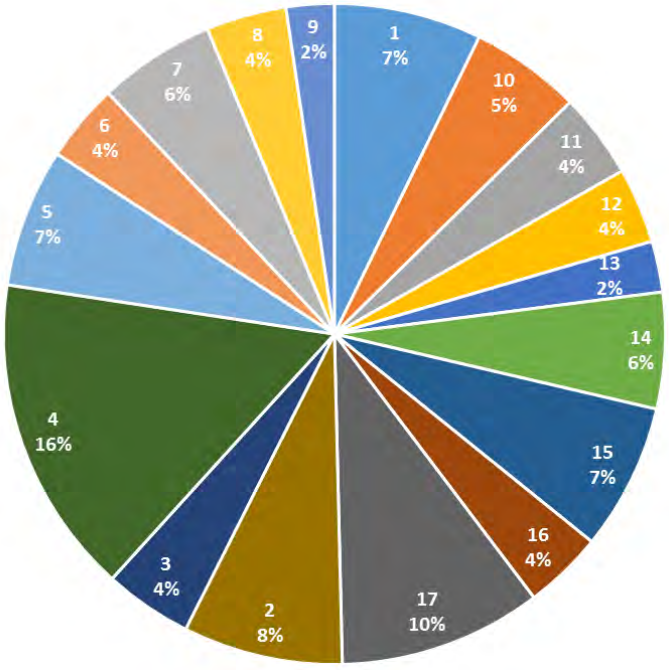
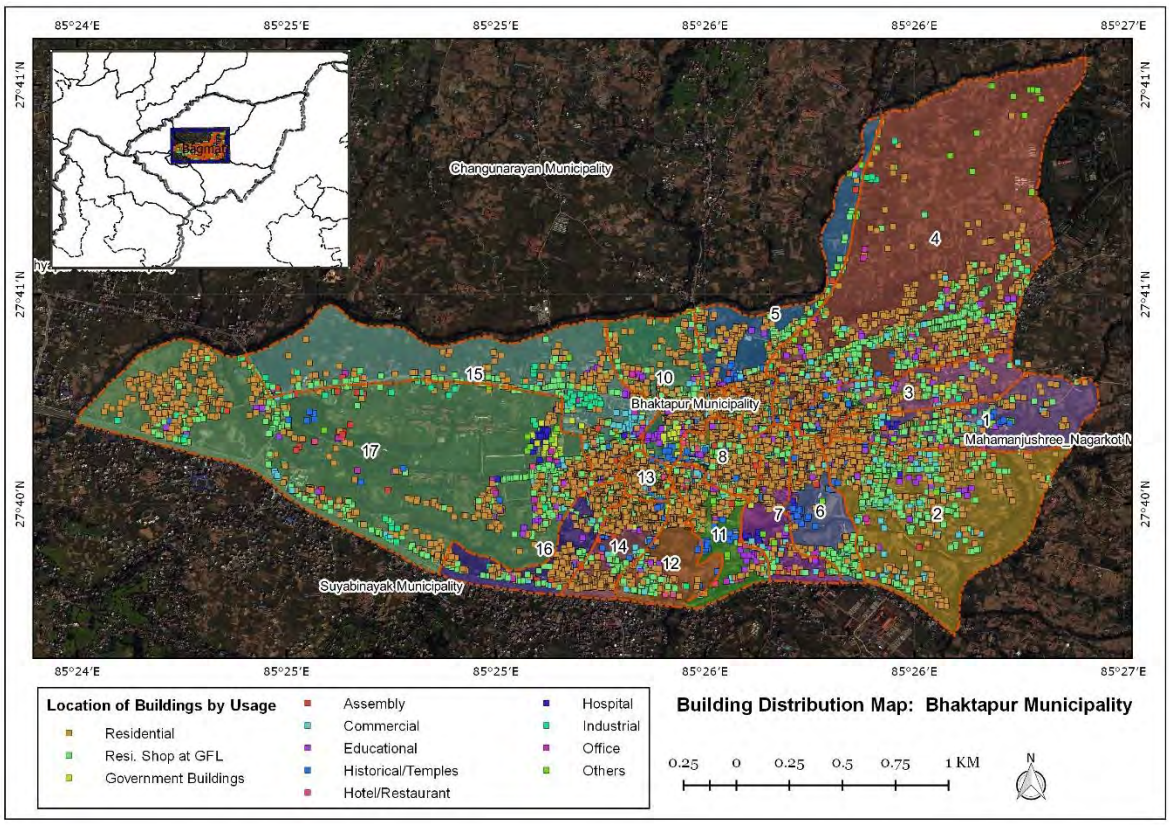


Fig. 4-1: Ward-wise percentage distribution of buildings surveyed in Bhaktapur Municipality.

The wards 4, 2, 17 are highly density area in terms of buildings. In terms of building distribution, the central city has higher number of building. The spatial distribution with building uses has shown in Map 4-2 as following.



Map 4-2: Location of Bhaktapur Municipality and Building Distribution Survey.

The map shows majority of buildings in Bhaktapur Municipality is residential category, followed by the category with residential with shop at ground floor level (which is basically the building is dominated by residential purpose).

4.1.1 NUMBER OF STORIES

The Table 4-4 shows distribution of buildings according to the number of stories. The majority of buildings are 4 storied buildings.

Table 4-4: Number of Storey

No of Stories	Number of buildings	%	No of Stories	Number of buildings	%
1	1991	14.8	5	2144	15.9
2	2103	15.6	6	60	0.44
3	2750	20.4	7	4	0.03
4	4430	32.9	8	2	0.01
			Total	**13,905**	**100**

The majority of buildings is 4 storied buildings (33%), which is followed by 3 storied buildings about 20%, and 5 storied buildings about 15%. Altogether about 60% of the total buildings fall under 3-5 storied buildings category.

4.1.2 STRUCTURAL TYPE

By structural type of building the majority of buildings Brick with Mud Mortar followed by RC frame non-engineered buildings as shown in Fig. 4-2.

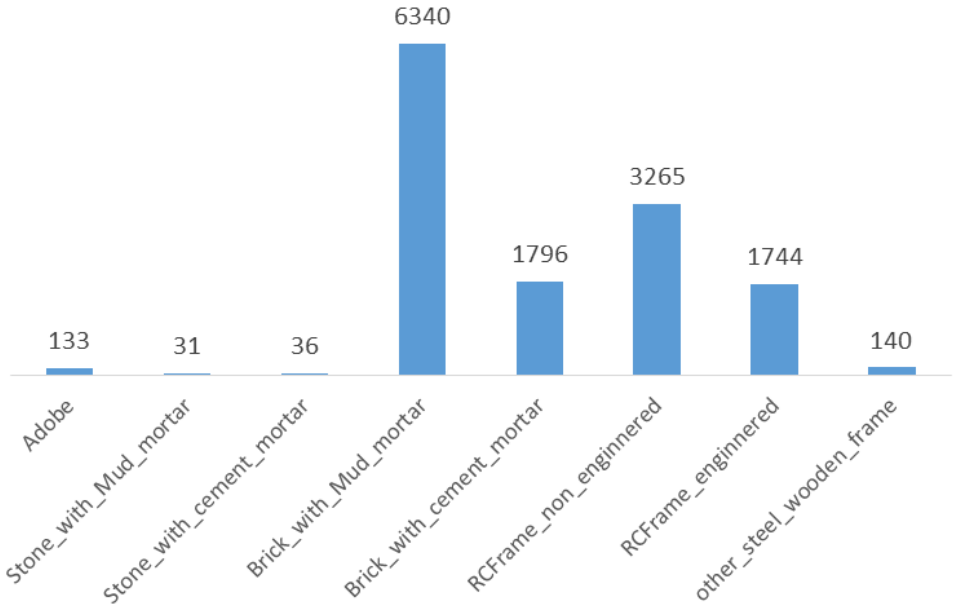


Fig. 4-2: Structural Type

4.1.3 USAGE

According to usage of buildings in Bhaktapur Municipality almost all of buildings are found used for residential purpose. For commercial purpose, shops at ground floor are used and upper stories are used for residential purposes (see Fig. 4-3). The remaining buildings are commercial, educational, government buildings, offices, industrial buildings, hotel restaurants, hospitals. Temples and historical buildings found significant in numbers.

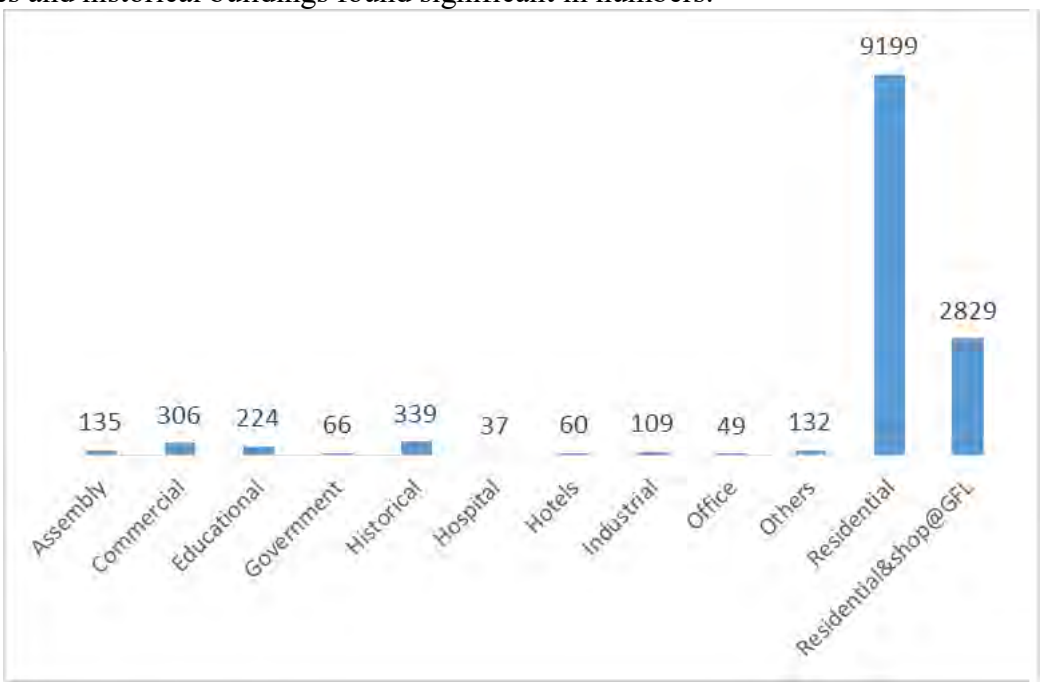


Fig. 4-3: Building Usage

4.1.4 CONSTRUCTION YEAR

According to construction year, i.e. age of building (Fig. 4-4) shows about 50% of buildings are under less than 20 years of age.

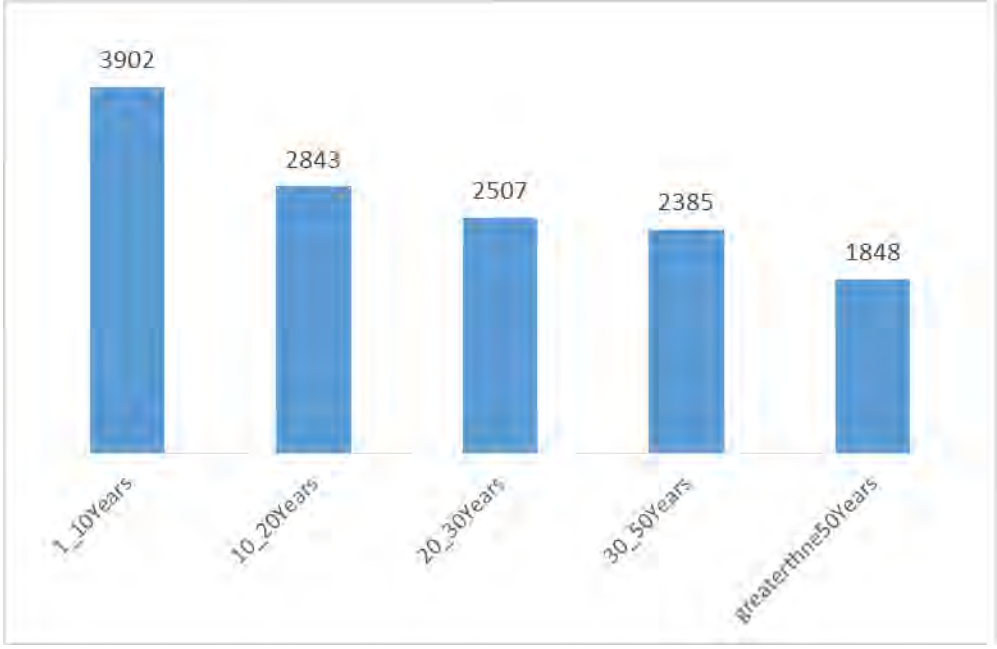


Fig. 4-4: Construction Year

The survey data shows, most of the buildings construction years (age of the building) shows greater than 30 years or so.

4.1.5 ROOF TYPE

There are pre-dominantly 3 roof types found in Bhaktapur Municipality namely, flexible wooden and CGI Sheets (about 50%), followed by rigid concrete and flexible wooden and clay.

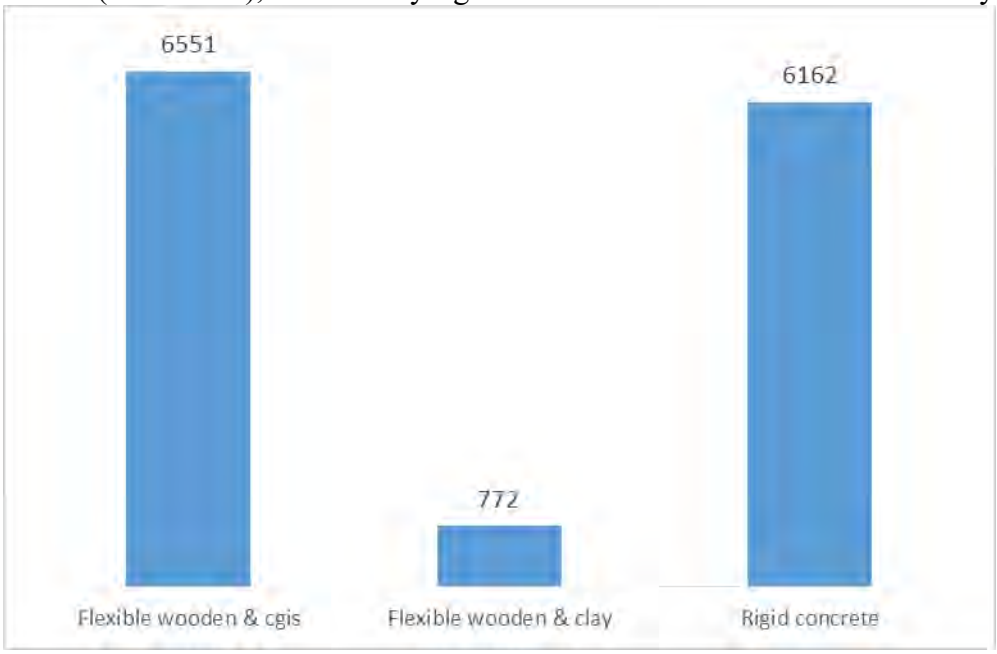


Fig. 4-5: Pre-dominant Roof Type of Buildings in Bhaktapur Municipality.

4.1.6 GROUND FAILURE

According to ground condition, about all of buildings were not found any ground failure. Only sixty-nine (66) cases of settlement, seven (7) cases of landslide and one (1) case of liquefaction were reported by responders.

4.1.7 IRREGULARITY

In terms of irregularity of building shape, there were major three types of irregularity found in Bhaktapur Municipality, which are regular, overhang and soft-storey. It is seem that Bhaktapur municipality have 92% of regular buildings found regular in shape.

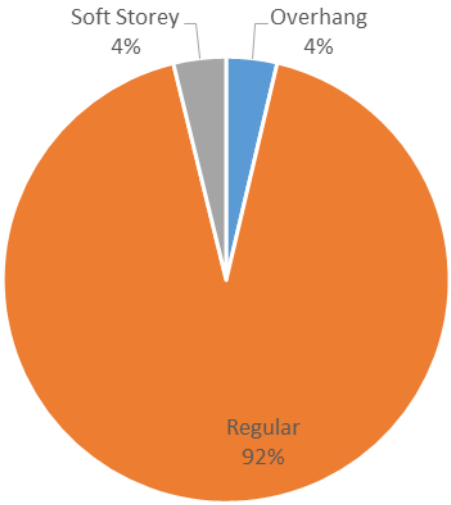


Fig. 4-6: Irregularity of Building Shape in Bhaktapur Municipality

4.1.8 ADJACENT BUILDINGS

The following Fig. 4-7 shows that there one side or free standing buildings are 25 % and 16 % of the total buildings respectively.

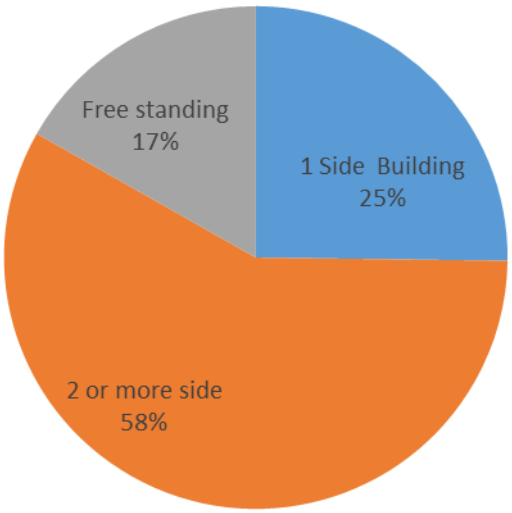


Fig. 4-7: Building Adjacency Characteristics in Bhaktapur Municipality

Since, most of the buildings lies in core wards of the municipality are in row-house. So, the majority of buildings shows are adjacent to both or more than two sides of the building.

4.1.9 LAND SLOPE

Bhaktapur municipality had different types of landscape. Most part of the buildings lies in flat land, there are still significant numbers of buildings lies in moderate slope angles. There are > 400 buildings are lies in > 30 degree slope or so. These buildings pose hazardous condition of landslides in case of earthquake, or landslide itself.

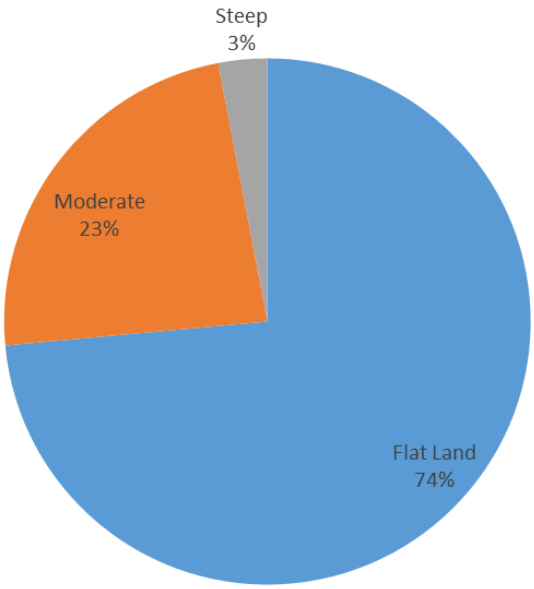


Fig. 4-8: Land slope

4.1.10 DAMAGE TO BUILDINGS

Regarding the damage degree, most important part of this survey, the following chart (Fig. 4-9) shows that there are about 57 % of building lies under category of Damage Grade 1. About 14% are in damage grade 2, 12% in damage grade 3, 10% in damage grade 4, and 7% in Damage grade 5 were recorded. The details can be seen in Table 4-5, in section 4.2 below, for ward-wise distribution of damage.

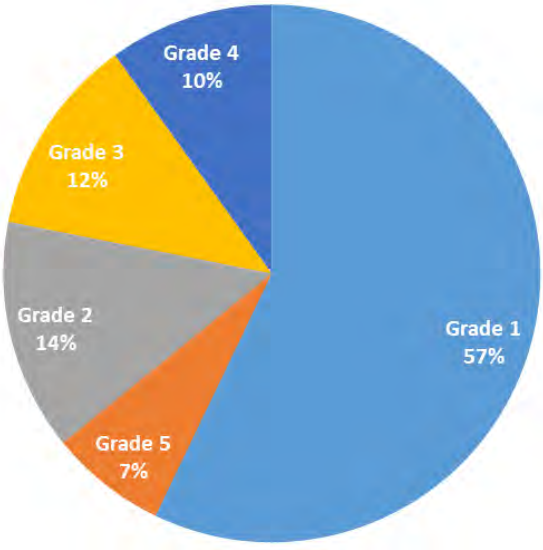


Fig. 4-9: Percentage distribution of damage degree of buildings in Bhaktapur Municipality.

4.2 DAMAGE DEGREE AND STRUCTURAL TYPE

The following Table 4-5 shows the summary of damaged buildings, damage grade (DG) by structural types of the building.

Table 4-5: Structural Type of Building and Damage Grade in Bhaktapur Municipality.

Structural Type	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total	% distribution
Adobe	24	20	24	27	38	133	0.99
Stone with Mud Mortar	10	7	6	4	4	31	0.23
Stone with Cement Mortar	19	11	2	3	1	36	0.27
Brick with Mud Mortar	1263	1482	1475	1239	881	6340	47.02
Brick with Cement Mortar	1387	248	83	59	19	1796	13.32
RC Frame Non-engineered	3132	97	27	4	5	3265	24.21
RC Frame Engineered	1734	10				1744	12.93
Steel Wooden Frame	135	3		2		140	1.04
Total number of buildings	7704	1878	1617	1338	948	13485	
% distribution	57.13	13.93	11.99	9.92	7.03		

While looking Table 4-5 about 17% of buildings are under DG 4 and DG 5 Category which needs to be demolished (about 2,500 in numbers). DG 1 buildings are about 57%, and moderate (under DG 2 and DG 3) comprises about 26% of total buildings.

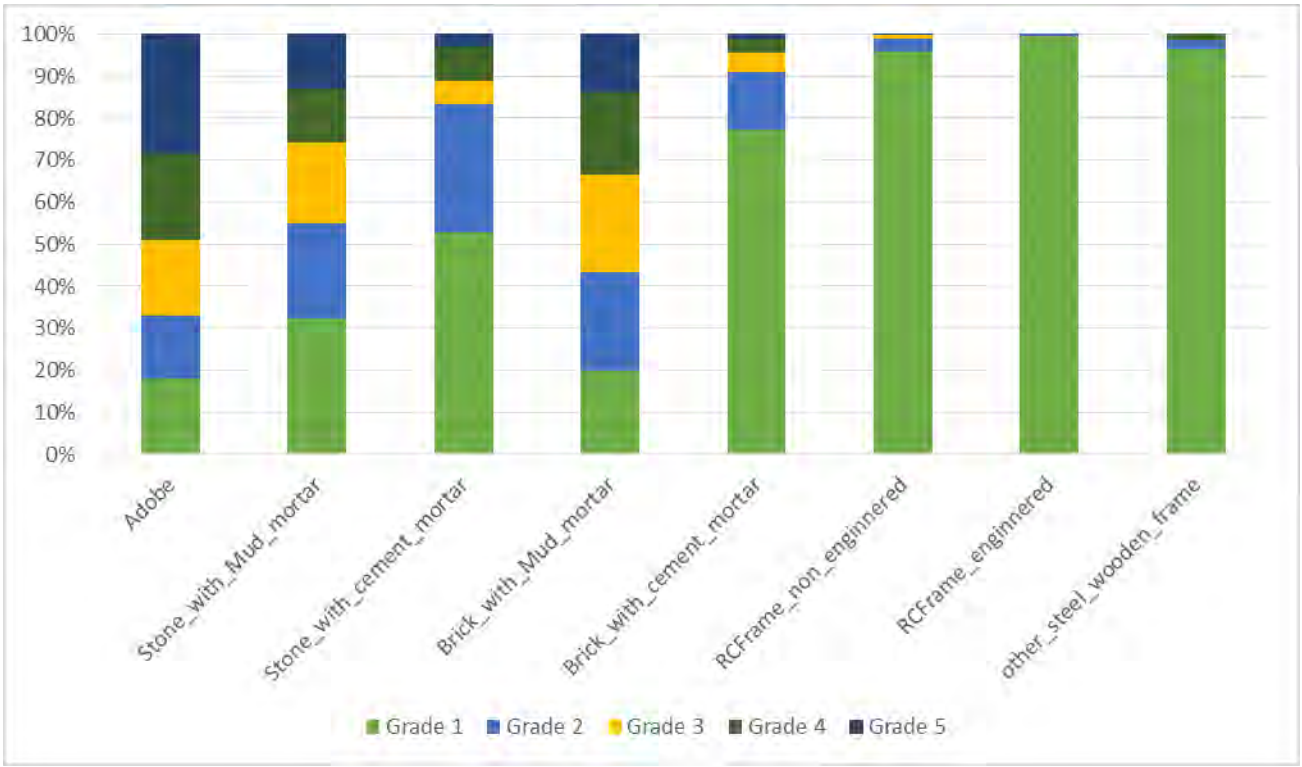


Fig. 4-10: Damage Grade by Building Typologies in Bhaktapur Municipality.

From the above Fig. 4-10, it is clearly visible that the majority of higher degree of damage is seen in BMM and BCM type of buildings whereas RC Frame (engineered and non-engineered has less damage).

4.3 Ward Wise Information of Bhaktapur Municipality

4.3.1 Number of Stories

According to the number of stories, one third of buildings are under 4 storied, followed by three storied. Five and two storied percentage comprises about same numbers (each about 16%). Only 6 buildings were found under 7 or 8 storied buildings.

Table 4-6: Ward-wise distribution of buildings by number of stories in Bhaktapur Municipality.

Ward Number	Number of Stories								
	1	2	3	4	5	6	7	8 or >	Total
1	187	151	188	329	116	2			973
2	223	239	244	229	113	4			1052
3	89	77	117	241	57				581
4	317	403	470	667	251	2		1	2111
5	118	128	154	366	148	3			917
6	75	63	110	182	79	8			517
7	55	50	91	281	286	5	3		771
8	54	55	87	229	102	2			529
9	32	38	54	112	79	1			316
10	139	140	161	200	88	1			729
11	107	117	122	158	56	2			562
12	102	76	90	128	97	3		1	497
13	35	36	65	118	76	6			336
14	100	97	181	275	109	5			767
15	126	143	179	314	199	5			966
16	54	51	118	206	93	1			523
17	179	239	319	395	195	10	1		1338
Total	1992	2103	2750	4430	2144	60	4	2	13485
%	14.77	15.60	20.39	32.85	15.90	0.44	0.03	0.01	

4.3.2 Structural Type

Ward-wise distribution of buildings by structural type is shown in following Table 4-7.

Table 4-7: Ward-wise distribution of buildings by structural type

Ward Number	Adobe	SMM	SCM	BMM	BCM	RC Frame Non-Eng.	RC Frame Eng.	Others	Total
1	13	4	2	616	92	162	75	9	973
2	12	2	6	329	86	278	294	45	1052
3	3		2	409	87	69	10	1	581
4	45	6	6	697	215	614	515	13	2111
5	11	2	4	495	133	235	33	4	917
6				284	102	103	26	2	517
7		4		477	105	117	64	4	771
8	3	1		319	92	89	23	2	529
9	3		1	221	54	35	2		316
10		3		317	98	203	105	3	729
11	1	1	4	300	115	98	36	7	562
12	4		1	270	58	135	26	3	497
13	1	1	1	233	47	40	13		336

Ward Number	Adobe	SMM	SCM	BMM	BCM	RC Frame Non-Eng.	RC Frame Eng.	Others	Total
14	7			381	105	200	68	6	767
15	5	2	1	428	142	305	64	19	966
16	3			283	70	112	49	6	523
17	22	5	8	281	195	470	341	16	1338
Total	133	31	36	6340	1796	3265	1744	140	13485
%	0.99	0.23	0.27	47.02	13.32	24.21	12.93	1.04	

Where, BCM = Brick in Cement mortar, BMM= Brick in Mud Mortar, SCM= Stone in Cement Mortar, SMM= Stone in Mud Mortar RC Frame (Eng) = Engineered Designed RC Frame, RC Frame (NonEng)= Non Engineered RCFrame Structure, Mixed = Combination of two or more

4.3.3 IRREGULARITY

Ward-wise distribution of buildings by Irregularity type is shown in following Table 4-8.

Table 4-8: Ward-wise distribution of buildings with irregularities in Bhaktapur Municipality.

Ward Number	Overhang	Regular	Soft Storey	Grand Total
1	19	931	23	973
2	18	1007	27	1052
3	5	561	15	581
4	13	2024	74	2111
5	6	905	6	917
6	1	500	16	517
7		751	20	771
8	1	520	8	529
9	25	288	3	316
10	34	660	35	729
11	19	521	22	562
12	99	377	21	497
13	14	318	4	336
14	12	746	9	767
15	37	869	60	966
16	1	512	10	523
17	202	958	178	1338
Total	**506**	**12448**	**531**	**13485**

In addition to above table 4-8, the following table 4-8 (b) also shows the ward-wise distribution of building by irregularities according to the structural type of building especially RC Frame Non-Engineered and RC Frame Engineered buildings in Bhaktapur Municipality.

Table 4-8 (b) Ward wise distributions of buildings by irregularities according to structure type

	Soft Storey				Overhanging				Ordinary (Regular)				
Ward Number	**RC Frame Non-Engineered**		**RC Frame Engineered**		**RC Frame Non-Engineered**		**RC Frame Engineered**		**RC Frame Non-Engineered**		**RC Frame Engineered**		**Total Building**
	N0/%		**N0/%**		**N0/%**		**N0/%**		**N0/%**		**N0/%**		
1	6	0.6		0.0	10	1.0	1	0.1	146	15.1	74	7.6	969
2	11	1.0	3	0.3	12	1.1		0.0	255	24.3	291	27.7	1050
3	3	0.5	1	0.2	4	0.7		0.0	62	10.7	9	1.5	581
4	4	0.2	24	1.1	6	0.3	1	0.0	604	28.7	490	23.3	2105
5	1	0.1	1	0.1	6	0.7		0.0	228	24.9	32	3.5	915

	Soft Storey				Overhanging				Ordinary (Regular)				
Ward Number	RC Frame Non-Engineered		RC Frame Engineered		RC Frame Non-Engineered		RC Frame Engineered		RC Frame Non-Engineered		RC Frame Engineered		Total Building
	N0/%		N0/%		N0/%		N0/%		N0/%		N0/%		
6	3	0.6	1	0.2	1	0.2		0.0	99	19.1	25	4.8	517
7	2	0.3	1	0.1		0.0		0.0	115	15.0	63	8.2	767
8		0.0		0.0		0.0		0.0	89	16.9	23	4.4	528
9		0.0		0.0	8	2.5	1	0.3	27	8.5	1	0.3	316
10	7	1.0	1	0.1	18	2.5	6	0.8	178	24.5	98	13.5	726
11	5	0.9		0.0	8	1.4		0.0	85	15.2	36	6.4	561
12	6	1.2	2	0.4	50	10.1	12	2.4	79	15.9	12	2.4	497
13		0.0		0.0	1	0.3	1	0.3	39	11.6	12	3.6	335
14	1	0.1	1	0.1	2	0.3		0.0	197	25.7	67	8.7	767
15	26	2.7	2	0.2	20	2.1		0.0	259	26.9	62	6.4	964
16	3	0.6	1	0.2		0.0		0.0	109	20.8	48	9.2	523
17	102	7.7	17	1.3	134	10.1	23	1.7	234	17.6	301	22.6	1333
Total	**180**		**55**		**280**		**45**		**2805**		**1644**		

4.3.4 USAGE

According to use of buildings are shown in following Table 4-8, majority of buildings show are used for residential purposes. There is significant proportion/percentage of buildings are also used for both residential cum commercial purpose with ground floor used for such commercial purpose.

Table 4-8: Ward-wise distribution of building use in Bhaktapur Municipality.

Ward Number	Building Usages												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
1	693	179	2	25	6	6	2	27		3	16	10	969
2	644	298	3	59	22	1		12	1	2	1	7	1050
3	449	77	2	6	2			36	3	2	4		581
4	1330	575	4	52	42	1	7	34	3	17	6	34	2105
5	673	169	1	9	11		2	30		2	7	11	915
6	376	93		4	6			27		3	6	2	517
7	511	153	3	14	12	10	1	26	3	1	21	12	767
8	348	127		15	8			17	2		4	7	528
9	259	36		2	3		1	7	4		2	2	316
10	510	110	6	23	20	2	21	17	7		6	4	726
11	346	106	4	20	19		4	26	17		12	7	561
12	358	101	1	10	2		1	18	3	1	2		497
13	252	50		8	6			9	3		2	5	335
14	626	85	1	13	11		1	15	5	1	5	4	767
15	619	209	6	20	20	1	15	7	5	41	9	12	964
16	387	96	3	3	13		1	5		1	9	5	523
17	802	364	13	23	21	16	10	17	4	33	20	10	1333
Total	9183	2828	49	306	224	37	66	330	60	107	132	132	13454

Building Usage: Where 1= Residence, 2= Residence & shop at GFL, 3= Office, 4=Commercial, 5= Education, 6= Hospital, 7= Governmental, 8= Historical & Temple, 9= Hotel & Restaurant, 10= Industry, 11= Assembly, 12= others

4.3.5 CONSTRUCTION YEAR

Ward-wise distribution of buildings by age of building. The table shows majority of building are relatively new, constructed within 10 years of time.

Table 4-9: Ward wise distribution of building according to age of construction.

Ward Number	Age of the Building					Total
	1- 10 Years	10-20 Years	20-30 Years	30-50 Years	> 50 Years	
1	260	187	147	272	103	969
2	486	169	151	155	89	1050
3	95	99	90	206	91	581
4	922	457	351	201	174	2105
5	201	151	175	202	186	915
6	76	156	98	92	95	517
7	97	147	111	133	279	767
8	103	68	116	100	141	528
9	27	46	96	126	21	316
10	127	166	154	186	93	726
11	77	122	109	101	152	561
12	104	90	78	126	99	497
13	51	51	69	41	123	335
14	215	241	126	93	92	767
15	328	230	290	82	34	964
16	156	113	143	69	42	523
17	572	344	200	192	25	1333
Total	**3897**	**2837**	**2504**	**2377**	**1839**	**13454**

4.3.6 ROOF TYPE

The dominant roof type is flexible wooden and CGI sheet however, newer development area dominates with rigid concrete roof type. Core areas have more flexible type of roofing (see Table 4-10).

Table 4-10: Ward-wise roof type distribution in Bhaktapur Municipality.

	Roof Type			
Ward Number	**Flexible wooden and CGI**	**Flexible wooden and clay**	**Rigid concrete**	**Total**
1	576	58	335	969
2	397	28	625	1050
3	363	69	149	581
4	689	94	1322	2105
5	438	81	396	915
6	304	33	180	517
7	509	32	226	767
8	270	86	172	528
9	223	24	69	316
10	340	30	356	726
11	330	45	186	561
12	293	20	184	497
13	219	21	95	335
14	397	31	339	767
15	499	47	418	964
16	298	24	201	523
17	387	39	907	1333
Total	**6532**	**762**	**6160**	**13454**

Table 4-10 (b): Ward wise distributions of buildings by Roof type according to structure type

Ward	**Flexible (Wooden & CGI)**				**Rigid (Concrete)**			
	BMM		BCM		BMM		BCM	
	No	%	No	%	No	%	No	%
1	520	53.7	29	3.0	51	5.3	52	5.4
2	288	27.4	39	3.7	18	1.7	45	4.3
3	329	56.6	27	4.6	23	4.0	48	8.3

4	525	24.9	74	3.5	97	4.6	134	6.4
5	371	40.5	43	4.7	57	6.2	78	8.5
6	254	49.1	42	8.1	11	2.1	50	9.7
7	438	57.1	60	7.8	14	1.8	40	5.2
8	222	42.0	41	7.8	19	3.6	46	8.7
9	198	62.7	20	6.3	4	1.3	30	9.5
10	281	38.7	43	5.9	14	1.9	48	6.6
11	256	45.6	61	10.9	11	2.0	50	8.9
12	249	50.1	29	5.8	7	1.4	25	5.0
13	200	59.7	16	4.8	16	4.8	27	8.1
14	332	43.3	48	6.3	29	3.8	49	6.4
15	382	39.6	81	8.4	17	1.8	49	5.1
16	245	46.8	39	7.5	16	3.1	31	5.9
17	239	17.9	79	5.9	13	1.0	109	8.2
Total	**5329**		**771**		**417**		**911**	

4.3.7 GROUND FAILURE

Eighty-two buildings were recorded (see Table 4-11) case of either ground failure, or settlement due to the earthquake. Most of the cases of landslides were found in Ward Number 1, whereas case of settlement found mostly wards 1 to 2 cases at least. The highest number of ground settlement were found in Ward Number 4, where 41 buildings noticed the case of ground settlement.

Table 4-11: Ward-wise ground failure conditions found in surveyed buildings in Bhaktapur.

	Ground Failure Characteristics				
Ward Number	**Landslide**	**Liquefaction**	**Settlement**	**Not Found**	**Total**
1	5		3	965	973
2			1	1051	1052
3	1		2	578	581
4			35	2076	2111
5			2	915	917
6				517	517
7			3	768	771
8			3	526	529
9			1	315	316
10			1	728	729
11			1	561	562
12	1		4	492	497
13			1	335	336
14			1	766	767
15		1	1	964	966
16				523	523
17			7	1331	1338
Total	**7**	**1**	**66**	**13411**	**13485**

4.3.8 ADJACENT BUILDINGS

Most of buildings are two side adjacent. These buildings are predominant in city core areas of the Municipality in Ward Number 4, Ward Number 1, Ward Number 7 (see Table 4-12).

Table 4-12: Ward-wise distribution of buildings with adjacent features in Bhaktapur Municipality.

Ward Number	**Adjacent Building**			
	Building in 1 side	**Building in 2 side & more**	**Free Standing**	**Grand Total**
1	190	648	135	973
2	362	471	219	1052

Ward Number	Adjacent Building			
	Building in 1 side	Building in 2 side & more	Free Standing	Grand Total
3	133	400	48	581
4	650	998	463	2111
5	244	544	129	917
6	169	306	42	517
7	116	562	93	771
8	106	390	33	529
9	40	254	22	316
10	193	415	121	729
11	122	368	72	562
12	101	331	65	497
13	47	261	28	336
14	195	497	75	767
15	227	541	198	966
16	106	364	53	523
17	398	471	469	1338
Total	**3399**	**7821**	**2265**	**13485**

4.3.9 LAND SLOPE

According to slope character of the land where building exist is dominated by flat land (see Table 4-13). Most of buildings are in flat-land followed by moderate and steep slopes respectively.

Table 4-13: Ward-wise building distribution with land slope in Bhaktapur Municipality.

Ward Number	Land slope			
	Flat Land	Moderate	Steep (>30 degree)	Total
1	790	171	12	973
2	716	287	49	1052
3	417	163	1	581
4	1885	214	12	2111
5	572	344	1	917
6	228	275	14	517
7	487	253	31	771
8	373	114	42	529
9	298	12	6	316
10	542	141	46	729
11	405	154	3	562
12	370	99	28	497
13	327	8	1	336
14	385	362	20	767
15	841	108	17	966
16	386	130	7	523
17	896	328	114	1338
Total	**9918**	**3163**	**404**	**13485**

4.3.10 DAMAGE TO BUILDINGS

Ward wise damage distribution of buildings is shown as following (Table 4-14). The detail of damage by structural types of buildings has discussed/shown in the Table 4-5 in previous pages.

Table 4-14: Ward-wise building damage distribution by damage grade in Bhaktapur.

Ward Number	Damage Grade					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grand Total
1	409	138	220	98	108	973
2	721	76	65	103	87	1052
3	228	115	123	49	66	581
4	1529	292	135	79	76	2111
5	469	159	97	136	56	917
6	236	82	58	58	83	517
7	332	45	59	188	147	771
8	248	78	61	86	56	529
9	104	62	86	47	17	316
10	400	78	123	83	45	729
11	297	66	76	58	65	562
12	225	72	75	70	55	497
13	157	63	71	31	14	336
14	450	101	100	84	32	767
15	641	184	81	45	15	966
16	243	110	72	86	12	523
17	1015	157	115	37	14	1338
Total	7704	1878	1617	1338	948	13485

4.4 DAMAGE DEGREE AND STRUCTURAL TYPE

The relation between structural type and damage grade by wards are shown in Table 4-15. The table in different section of the same table shows buildings damage grade according to the structural types of building.

Table 4-15: Ward-wise building damage distribution by damage grade and structural types

a) Adobe Buildings

	Damage degree according to Adobe structure type										
Ward	**(DG1)**	**%**	**(DG2)**	**%**	**(DG3)**	**%**	**(DG4)**	**%**	**(DG5)**	**%**	**Total**
1	0	0.0	0	0	7	0.72	1	0.10	5	0.52	969
2	4	0.4	1	0.09524	0	0.00	3	0.29	4	0.38	1050
3	0	0.0	0	0	2	0.34	1	0.17	0	0.00	581
4	10	0.5	8	0.38005	4	0.19	4	0.19	19	0.90	2105
5	1	0.1	3	0.32787	0	0.00	5	0.55	2	0.22	915
6	0	0.0	0	0	0	0.00	0	0.00	0	0.00	517
7	0	0.0	0	0	0	0.00	0	0.00	0	0.00	767
8	0	0.0	1	0.18939	0	0.00	1	0.19	1	0.19	528
9	0	0.0	1	0.31646	0	0.00	1	0.32	1	0.32	316
10	0	0.0	0	0	0	0.00	0	0.00	0	0.00	726
11	0	0.0	0	0	0	0.00	0	0.00	1	0.18	561
12	0	0.0	0	0	2	0.40	1	0.20	1	0.20	497
13	1	0.3	0	0	0	0.00	0	0.00	0	0.00	335
14	5	0.7	1	0.13038	0	0.00	0	0.00	1	0.13	767
15	1	0.1	1	0.10373	0	0.00	3	0.31	0	0.00	964
16	0	0.0	0	0	2	0.38	0	0.00	1	0.19	523
17	2	0.2	4	0.30008	7	0.53	7	0.53	2	0.15	1333
Total	24	0.2	20	0.14865	24	0.18	27	0.20	38	0.28	13454
% of	**(DG-4 + DG-5)**			0.48							
% of	**DG-3/2+DG-4 + DG-5)**			0.57							

b) Stone Mud Mortar

	Damage degree according to Stone Mud Mortar structure type										
Ward	**(DG1)**	**%**	**(DG2)**	**%**	**(DG3)**	**%**	**(DG4)**	**%**	**(DG5)**	**%**	**Total**
1	0.0	0.0	1.0	0.1	0.0	0.0	2.0	0.2	1.0	0.1	969
2	1.0	0.1	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1050
4	2.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2105
5	2.0	0.2	0.0	0.0	1.0	0.1	1.0	0.1	0.0	0.0	915

7	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	767
8	1.0	0.2	1.0	0.2	1.0	0.2	0.0	0.0	0.0	0.0	528
10	0.0	0.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	726
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.2	561
13	0.0	0.0	0.0	0.0	1.0	0.3	1.0	0.3	0.0	0.0	335
15	1.0	0.1	0.0	0.0	2.0	0.2	0.0	0.0	2.0	0.2	964
17	10.0	0.8	7.0	0.5	6.0	0.5	4.0	0.3	4.0	0.3	1333
Total	18.0	0.2	11.0	0.1	11.0	0.1	8.0	0.1	8.0	0.1	10253
% of	**(DG-4 + DG-5)**			0.16							
% of	**DG-3/2+DG-4 + DG-5)**			0.21							

c) Stone Cement Mortar

	Damage degree according to Stone Cement Mortar structure type										
Ward	**(DG1)**	**%**	**(DG2)**	**%**	**(DG3)**	**%**	**(DG4)**	**%**	**(DG5)**	**%**	**Total**
1	1	0.10	1	0.10	0	0.00	0	0.00	0	0.00	969
2	1	0.10	5	0.48	0	0.00	0	0.00	0	0.00	1050
3	4	0.69	1	0.17	0	0.00	0	0.00	1	0.17	581
4	2	0.10	2	0.10	0	0.00	0	0.00	0	0.00	2105
5	0	0.00	0	0.00	1	0.11	0	0.00	0	0.00	915
9	1	0.32	0	0.00	1	0.32	2	0.63	0	0.00	316
11	0	0.00	0	0.00	0	0.00	1	0.18	0	0.00	561
12	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	497
13	1	0.30	0	0.00	0	0.00	0	0.00	0	0.00	335
15	6	0.62	2	0.21	0	0.00	0	0.00	0	0.00	964
17	19	1.43	11	0.83	2	0.15	3	0.23	1	0.08	1333
Total	36.0	0.37	22.0	0.23	4.0	0.04	6.0	0.06	2.0	0.02	9626.0
% of	**(DG-4 + DG-5)**			0.08							
% of	**DG-3/2+DG-4 + DG-5)**			0.10							

d) Brick with Mud Mortar

	Damage degree according to Brick with Mud Mortar structure type										
Ward	(DG1)	%	(DG2)	%	(DG3)	%	(DG4)	%	(DG5)	%	Total
1	99	10.22	122	12.5903	204	21.05	91	9.39	100	10.32	969
2	57	5.43	36	3.42857	58	5.52	96	9.14	82	7.81	1050
3	74	12.74	106	18.2444	115	19.79	48	8.26	66	11.36	581
4	240	11.40	217	10.3088	119	5.65	69	3.28	52	2.47	2105
5	91	9.95	141	15.4098	86	9.40	123	13.44	54	5.90	915
6	31	6.00	69	13.3462	50	9.67	54	10.44	80	15.47	517
7	65	8.47	36	4.69361	54	7.04	177	23.08	145	18.90	767
8	63	11.93	64	12.1212	58	10.98	80	15.15	54	10.23	528
9	27	8.54	50	15.8228	82	25.95	46	14.56	16	5.06	316
10	35	4.82	45	6.19835	113	15.56	80	11.02	44	6.06	726
11	66	11.76	54	9.62567	71	12.66	51	9.09	58	10.34	561
12	28	5.63	55	11.0664	70	14.08	63	12.68	54	10.87	497
13	61	18.21	61	18.209	69	20.60	29	8.66	13	3.88	335
14	84	10.95	90	11.734	95	12.39	82	10.69	30	3.91	767
15	149	15.46	149	15.4564	76	7.88	40	4.15	14	1.45	964
16	32	6.12	93	17.782	65	12.43	82	15.68	11	2.10	523
17	61	4.58	94	7.05176	90	6.75	28	2.10	8	0.60	1333
Total	1263.0	9.39	1482.0	11.0153	1475.0	10.96	1239.0	9.21	881.0	6.55	13454
% of	(DG-4 + DG-5)			15.76							
% of	DG-3/2+DG-4 + DG-5)			21.24							

e) Brick with Cement Mortar

	Damage degree according to Brick with Cement Mortar structure type										
Ward	**(DG1)**	**%**	**(DG2)**	**%**	**(DG3)**	**%**	**(DG4)**	**%**	**(DG5)**	**%**	**Total**
1	75	0.1	7.0	0.7	6.0	0.6	3.0	0.0	1.0	0.0	969
2	57	0.1	19.0	1.8	5.0	0.5	4.0	0.0	1.0	0.0	1050
3	74	0.1	9.0	1.5	4.0	0.7	0.0	0.0	0.0	0.0	581
4	165	0.1	36.0	1.7	5.0	0.2	5.0	0.0	4.0	0.0	2105
5	108	0.1	9.0	1.0	10.0	1.1	6.0	0.0	0.0	0.0	915
6	78	0.2	10.0	1.9	7.0	1.4	4.0	0.0	3.0	0.0	517
7	82	0.1	8.0	1.0	3.0	0.4	10.0	0.0	2.0	0.0	767
8	74	0.1	12.0	2.3	0.0	0.0	5.0	0.0	1.0	0.0	528
9	40	0.1	11.0	3.5	3.0	0.9	0.0	0.0	0.0	0.0	316
10	66	0.1	22.0	3.0	6.0	0.8	3.0	0.0	1.0	0.0	726
11	95	0.2	9.0	1.6	4.0	0.7	4.0	0.0	3.0	0.0	561
12	38	0.1	13.0	2.6	2.0	0.4	5.0	0.0	0.0	0.0	497
13	42	0.1	1.0	0.3	2.0	0.6	2.0	0.0	0.0	0.0	335
14	89	0.1	8.0	1.0	5.0	0.7	2.0	0.0	1.0	0.0	767
15	117	0.1	21.0	2.2	2.0	0.2	1.0	0.0	1.0	0.0	964
16	48	0.1	13.0	2.5	5.0	1.0	4.0	0.0	0.0	0.0	523
17	139	0.1	40.0	3.0	14.0	1.1	1.0	0.0	1.0	0.0	1333
Total	1387	0.1	248.0	1.8	83.0	0.6	59.0	0.0	19.0	0.0	13454
% of	**(DG-4 + DG-5)**			0.01							
% of	**DG-3/2+DG-4 + DG-5)**			0.31							

f) RC Frame Non-Engineered

	Damage degree according to RCFrame Non Engineered structure type										
Ward	(DG1)	%	(DG2)	%	(DG3)	%	(DG4)	%	(DG5)	%	Total
1	151	15.58	7	0.72	3	0.31	0	0.00	1	0.10	969
2	263	25.05	13	1.24	2	0.19	0	0.00	0	0.00	1050
3	67	11.53	0	0.00	2	0.34	0	0.00	0	0.00	581
4	584	27.74	23	1.09	6	0.29	1	0.05	0	0.00	2105
5	228	24.92	4	0.44	1	0.11	2	0.22	0	0.00	915
6	99	19.15	3	0.58	1	0.19	0	0.00	0	0.00	517
7	115	14.99	1	0.13	1	0.13	0	0.00	0	0.00	767
8	85	16.10	1	0.19	3	0.57	0	0.00	0	0.00	528
9	35	11.08	0	0.00	0	0.00	0	0.00	0	0.00	316
10	191	26.31	9	1.24	3	0.41	0	0.00	0	0.00	726
11	93	16.58	2	0.36	0	0.00	0	0.00	3	0.53	561
12	131	26.36	3	0.60	1	0.20	0	0.00	0	0.00	497
13	39	11.64	1	0.30	0	0.00	0	0.00	0	0.00	335
14	199	25.95	1	0.13	0	0.00	0	0.00	0	0.00	767
15	290	30.08	13	1.35	2	0.21	0	0.00	0	0.00	964
16	110	21.03	2	0.38	0	0.00	0	0.00	0	0.00	523
17	452	33.91	14	1.05	2	0.15	1	0.08	1	0.08	1333
Total	3132	23.28	97	0.72	27	0.20	4	0.03	5	0.04	13454
% of	(DG-4 + DG-5)			0.07							
% of	DG-3/2+DG-4 + DG-5)			0.17							

g) RC Frame Engineered

	Damage degree according to RCFrame Engineer structure type										
Ward	(DG1)	%	(DG2)	%	(DG3)	%	(DG4)	%	(DG5)	%	Total
1	75	7.74		0.00							969
2	293	27.90	1	0.10							1050
3	10	1.72		0.00							581
4	511	24.28	4	0.19							2105
5	33	3.61		0.00							915
6	26	5.03		0.00							517
7	64	8.34		0.00							767
8	23	4.36		0.00							528
9	2	0.63		0.00							316

	Damage degree according to RCFrame Engineer structure type										
Ward	(DG1)	%	(DG2)	%	(DG3)	%	(DG4)	%	(DG5)	%	Total
10	104	14.33	1	0.14							726
11	36	6.42		0.00							561
12	26	5.23		0.00							497
13	13	3.88		0.00							335
14	68	8.87		0.00							767
15	64	6.64		0.00							964
16	48	9.18	1	0.19							523
17	338	25.36	3	0.23							1333
Total	1734	12.89	10	0.07							13454
% of	(DG-4 + DG-5)			0							
% of	DG-3/2+DG-4 + DG-5)			0							

h) Other Structural Types

	Damage degree according to Others structure type										
Ward	**(DG1)**	**%**	**(DG2)**	**%**	**(DG3)**	**%**	**(DG4)**	**%**	**(DG5)**	**%**	**Total**
1	8	0.83	0	0.00			1	0.10			969
2	45	4.29	0	0.00			0	0.00			1050
3	1	0.17	0	0.00			0	0.00			581
4	13	0.62	0	0.00			0	0.00			2105
5	4	0.44	0	0.00			0	0.00			915
6	2	0.39	0	0.00			0	0.00			517
7	4	0.52	0	0.00			0	0.00			767
8	2	0.38	0	0.00			0	0.00			528
10	3	0.41	0	0.00			0	0.00			726
11	6	1.07	0	0.00			1	0.18			561
12	2	0.40	1	0.20			0	0.00			497
14	5	0.65	1	0.13			0	0.00			767
15	19	1.97	0	0.00			0	0.00			964
16	5	0.96	1	0.19			0	0.00			523
17	16	1.20	0	0.00			0	0.00			1333
Total	135	1.05	3	0.02			2	0.02			12803
% of	**(DG-4 + DG-5)**			0.02							
% of	**DG-3/2+DG-4 + DG-5)**			0.02							

ACTIVITY 2: BUILDING SURVEY IN KATHMANDU VALLEY

The scope of work for Activity 2 was specified as the survey of sample buildings in 19 Municipalities in Kathmandu Valley (KV). Each Municipality was supposed to survey approximately 500 buildings totaling of 10,000 buildings within KV. For present survey purpose, total number of buildings surveyed for this activity was 11025buildings in 17 Municipalities in KV. This section of report presents summary of the data carried out under this activity.

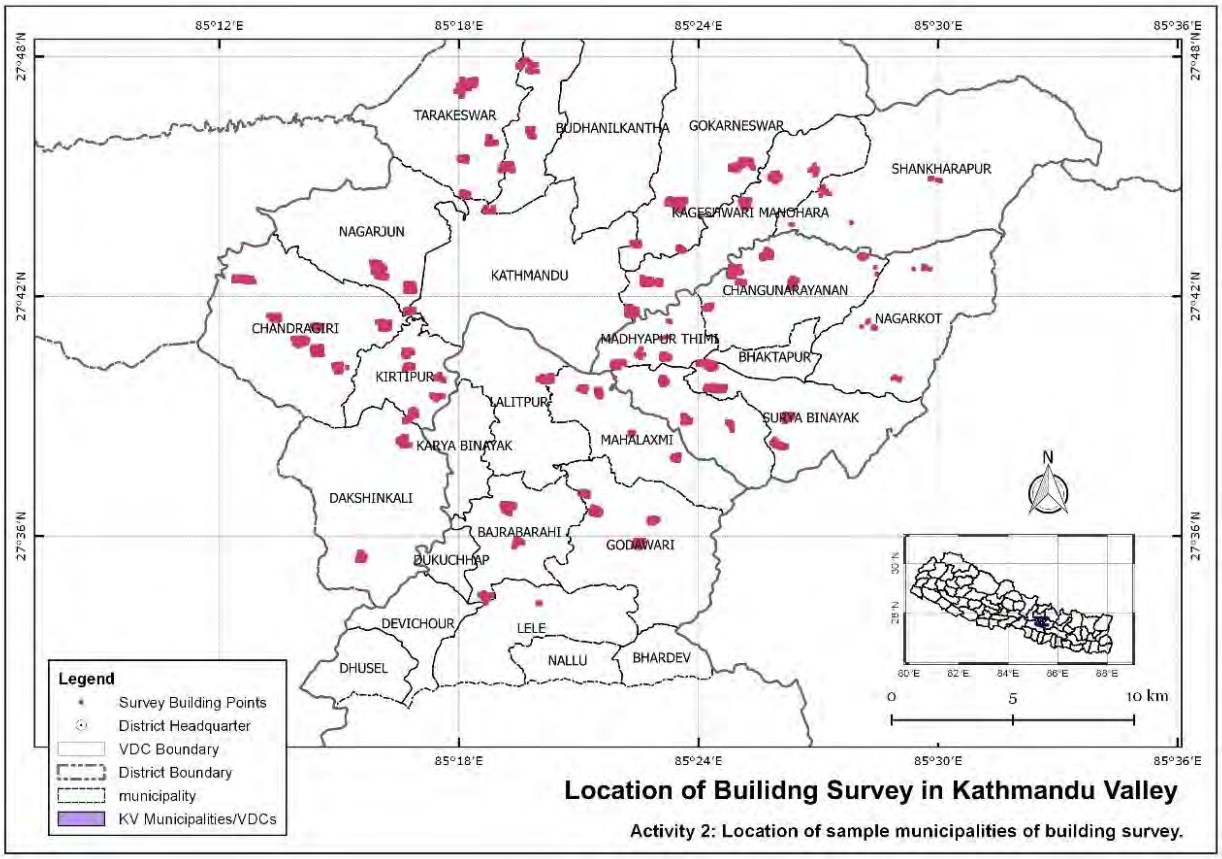
4.5 BUILDING SURVEY

Total number of buildings surveyed in the Kathmandu Valley Municipalities are 11025 in numbers. The Table 4-16 below shows the total number of sample by each KV Municipality and the location of settlements taken for sample survey.

Table 4-16: Settlement wise distribution of buildings surveyed in Kathamandu Valley.

Municipality/ Settlement	Total Building		Municipality/ Settlement	Total Building		Municipality/ Settlement	Total Building
Anantalingeshore	**558**		**Gokarneshowr**	**816**		Gattaghar	187
Balkot	275		Deshe Gokarna	69		Tachu	45
Charkhandi	41		Gokarneswor	303		Bode	182
Dadhikot	152		Jorpati	130		**Nagarjune**	**499**
Dokathali	92		Mulpani	95		Bafal	108
Bajrabarahi	**619**		Sundarijal	219		Kalanki	100
Chapagaun	126		**Kirtipur**	**690**		Ramkot	189
Lele	100		Chilanchobal	322		Soltidobato	102
Thecho	286		Chovar	97		**Suryabinayak**	**795**
Tikabhairab	107		Panga	169		Bairikhel	91
Chandragiri	**1067**		Taudaha	101		Katunje	276
Bauthali chowk	126		**KageshoreManahara**	**1031**		Sipadol	206
Gurjudhara	198		Aalapot	238		Srijananagar	222
Machhegaun	148		Bhadrabas	215		**Shankarapur**	**483**
Matatirtha	183		Gagalphedi	59		Bhulbhu	139
Naikap	199		Gothatar	155		Indrayani	91
Thankot	213		Kadaghari	364		Jarsingpauwa	54
			Mahalaxmi	**633**		Sankhu	199
Changunarayan	**718**		Gwarko	320		**Tokha**	**458**
Changunarayan	194		Imadol	124		Banayatar	109
Kapahiti	65		Lamatar	78		Jhor	106
NEC AREA	163		Lubhu	12		Siddhitol	109
Pikhel	147		Tikathali	99		Tokha Chandeswori	69
Sarasawatikhel	149		**Mahamanjushree (Nagarkot)**	**549**		Tokha Saraswati	65
Dakchinkali	**228**		Chaap	138		**Tarkeshore**	**588**
Pharping	228		Nagarkot	114		Futung	77
Godawari	**760**		Sudal	201		Ghatkekhola	70
Badegaun	199		Telkot	96		Jaranku	143
Bisankhu	176		**Madyapur Thimi**	**548**		Kavresthali	146
Godawari	188		Bahakha bazaar	136		Nepaltar	152
Taukhel	197		Bode	180		**Grand Total**	11025

Distribution of samples locations for building inventory and damage survey by municipalities in KV is shown Map 4-3.



Map 4-3: Showing location of building damage survey in Kathmandu Valley.

In Kathmandu valley 3 Municipalities were not sampled for survey with consultation with JPT.

4.5.1 NUMBER OF STORIES

According to the survey, about 60% of the total buildings were 2-3 storied (about 30% each), followed by single storied buildings about 23%. About 0.5 % of building under 6 storied or above in KV.

Table 4-17: Number of Buildings by Number of Storeys.

	Number of Stories								
Municipalities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	> 7	Total
Anantalingeshore	182	147	149	68	12	0	0	0	558
Bajrabarahi	140	192	222	52	12	1	0	0	619
Chandragiri	234	306	366	128	30	2	1	0	1067
Changunarayan	244	276	163	33	2	0	0	0	718
Dakchinkali	25	44	75	60	24	0	0	0	228
Godawari	262	243	191	52	10	0	0	2	760
Gokarneshowr	157	303	245	80	27	4	0	0	816
Kirtipur	77	130	225	190	54	11	3	0	690
KageshoreManahara	236	339	335	101	18	1	0	1	1031
Mahalaxmi	104	165	215	110	31	8	0	0	633
Nagarkot manjushree	236	205	97	5	5	0	0	1	549
Madyapur Thimi	44	90	164	200	45	5	0	0	548
Nagarjune	93	121	164	88	27	3	2	1	499
Suryabinayak	228	236	232	78	19	2	0	0	795
Shankarapur	115	113	118	100	36	1	0	0	483

	Number of Stories								
Municipalities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	> 7	Total
Tokha	43	105	164	86	43	15	2	0	458
Tarkeshore	132	209	156	74	17	0	0	0	588
Total	2552	3224	3281	1505	412	53	8	5	11025
%	23.1	29.2	29.7	13.6	3.7	0.5	0.07	0.05	

The following chart also shows percentage distribution of building by number of stories by Municipalities in KV.

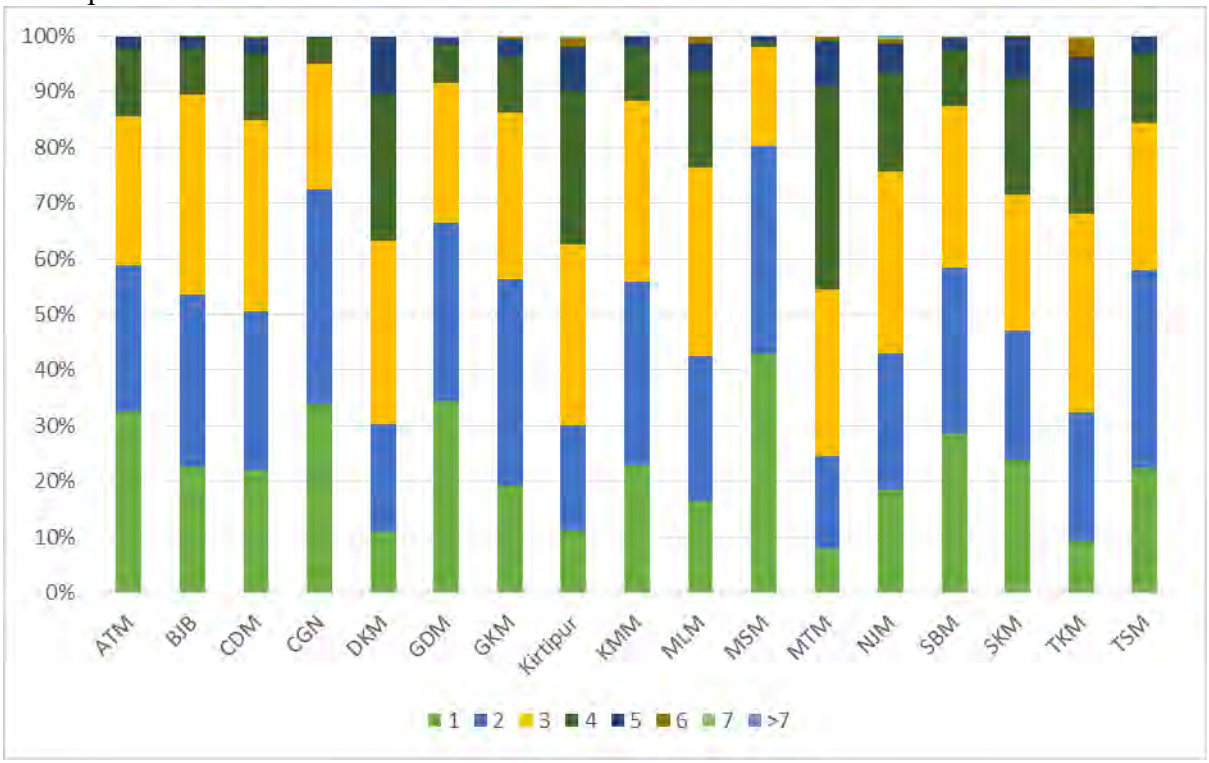


Fig. 4-11: Percentage distribution of buildings storey by Municipalities in KV.

4.5.2 STRUCTURAL TYPE

In Kathmandu Valley sample, the dominant structural type of building found that RC Frame Non Engineered (42%,) other major structural types are BCM (about 19%), BMM (16%), Adobe and Mixed 6% each. Category RC Frame Engineered buildings found about 5% (for detail see Table 4-18).

Table 4-18: Number of buildings by structural types by Municipalities in KV.

		Structural Types of Buildings								
Municipalities		**Adobe**	**Stone with Mud Mortar**	**Stone with Cement Mortar**	**Brick with Mud Mortar**	**Brick with Cement Mortar**	**RC Frame NonEng**	**RC Frame Eng**	**Other**	**Total**
Anantalingeshwore	ATM	0	2	5	96	79	282	35	59	558
Bajrabarahi	BJB	3	21	2	219	156	205	2	11	619
Chandragiri	CDM	10	36	8	63	298	485	164	3	1067
Changunarayan	CGN	72	25	2	237	75	239	17	51	718
Daxinkali	DKM	1	0	1	79	57	85	5	0	228
Godawari	GDM	55	52	12	171	233	209	23	5	760
Gokarneshwor	GKM	14	38	6	137	296	297	25	3	816
Kirtipur	KRT	12	29	2	194	259	175	17	2	690

		Structural Types of Buildings								
Municipalities		**Adobe**	**Stone with Mud Mortar**	**Stone with Cement Mortar**	**Brick with Mud Mortar**	**Brick with Cement Mortar**	**RC Frame NonEng**	**RC Frame Eng**	**Other**	**Total**
Kageswari-Manahara	KMM	56	98	3	78	172	494	123	7	1031
Mahalaxmi	MLM	16	2	0	59	64	426	51	0	618
Mahamanjushree	MSM	106	48	22	173	41	95	8	56	549
Madhyapur Thimi	MTM	0	0	0	133	84	317	13	1	548
Nagarjun	NJM	0	2	1	54	76	347	18	1	499
Suryabinayak	SBM	101	71	3	112	83	363	23	39	795
Shankharapur	SKM	117	15	1	157	71	81	26	15	483
Tokha	TKM	13	22	3	43	43	313	21	0	458
Tarkeshwor	TSM	112	9	2	51	86	319	6	3	588
Total		688	470	73	2056	2173	4732	577	256	
		6.24	4.26	0.66	18.65	19.71	42.92	5.23	2.32	**11025**

Where, BCM = Brick in Cement Mortar, BMM= Brick in Mud Mortar, SCM= Stone in Cement Mortar, SMM= Stone in Mud Mortar RC Frame (Eng) = Engineered Designed RC Frame, RC Frame (NonEng)= Non Engineered RCFrame Structure, Mixed = Combination of two or more

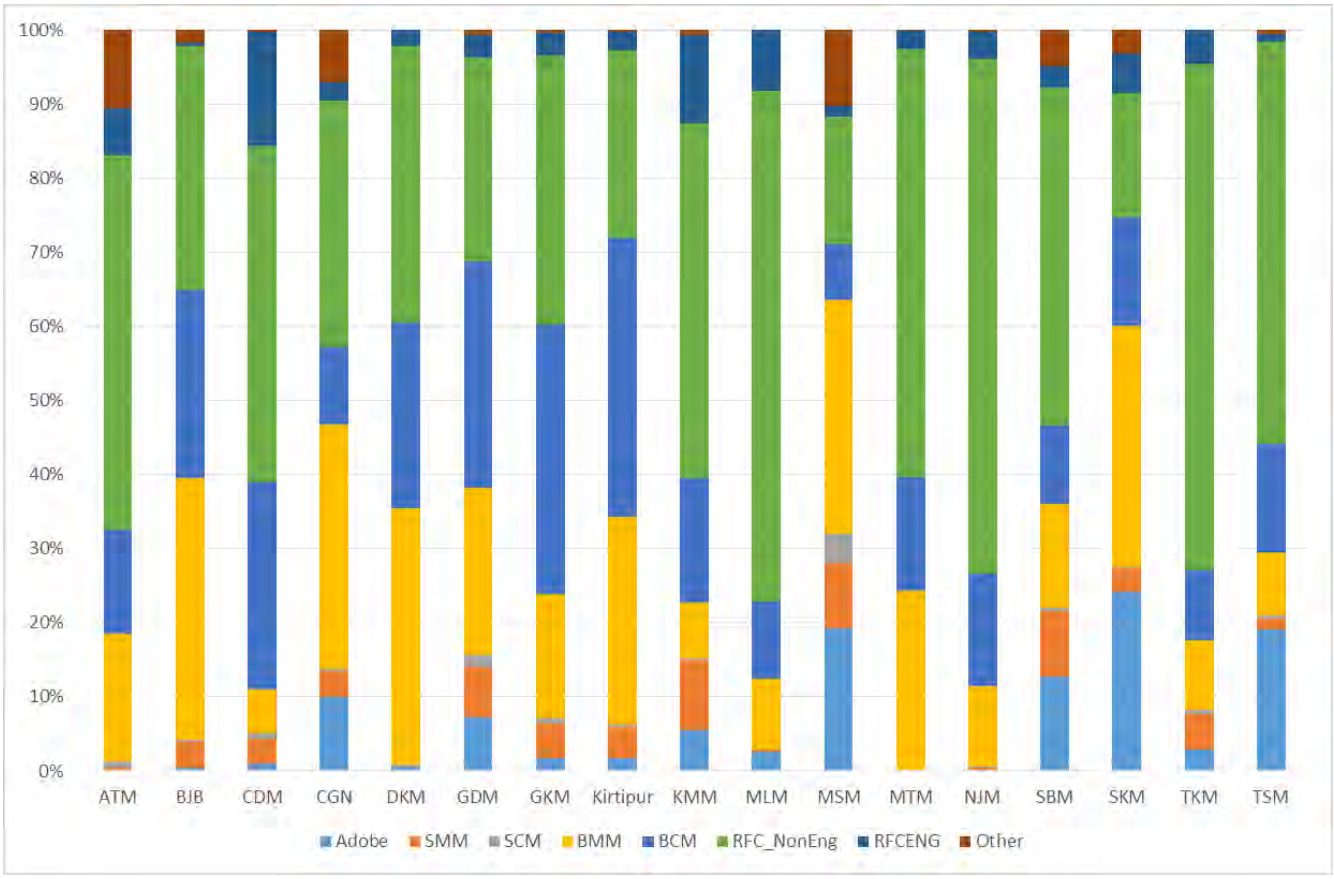


Fig. 4-12: Structural Type of Buildings in KV Municipalities.

4.5.3 USAGE

In KV, about 70% of buildings are used for residential purposes. Another 21% are found used for residential and commercial (shops at ground floor level). Only 4 % buildings found as used as commercial.

Table 4-19: Number of Buildings by Usase in Municipalities in KV.

		Usage												
Municipality		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Anantalingeshwore	ATM	390	38	0	90	26	0	1	2	2	0	0	9	558
Bajrabarahi	BJB	396	154	1	26	16	0	4	14	1	2	3	2	619
Chandragiri	CDM	632	334	3	41	22	1	6	3	4	10	1	10	1067
Changunarayan	CGN	562	49	0	42	21	0	0	22	1	1	5	15	718
Daxinkali	DKM	83	129	0	9	0	0	1	6	0	0	0	0	228
Godawari	GDM	543	154	5	26	11	4	6	3	2	4	0	2	760
Gokarneshwor	GKM	502	212	5	31	19	2	1	14		5	0	25	816
Kirtipur	KRT	474	161	2	14	5	0	1	10	5	1	16	1	690
Kageswari-Manahara	KMM	722	246		43	10	0	3	5	0	0	1	1	1031
Mahalaxmi	MLM	422	167	3	21	3	0	0	0	0	0	0	2	618
Mahamanjushree	MSM	504	14	4	7	5	1	5	3	2	3	0	1	549
Madhyapur Thimi	MTM	285	236	0	13	3	0	0	4	4	0	1	2	548
Nagarjun	NJM	364	103	3	20	4	3	0	1	1	0	0	0	499
Suryabinayak	SBM	655	51	4	23	4	1		3	1	2	1	50	795
Shankharapur	SKM	354	76	2	5	14	0	4	8	1	0	7	12	483
Tokha	TKM	252	146	0	44	5	1	0	0	9	0	0	1	458
Tarkeshwor	TSM	395	130	2	25	17	0	1	4	1	2	0	11	588
Total		7535	2400	34	480	185	13	33	102	34	30	35	144	11025
	%	68.34	21.77	0.31	4.35	1.68	0.12	0.30	0.93	0.31	0.27	0.32	1.31	

Where 1= Residence, 2= Residence & shop at GFL, 3= Office, 4=Commercial, 5= Education, 6= Hospital, 7= Governmental, 8= Historical & Temple, 9= Hotel & Restaurant, 10= Industry, 11= Assembly, 12= others

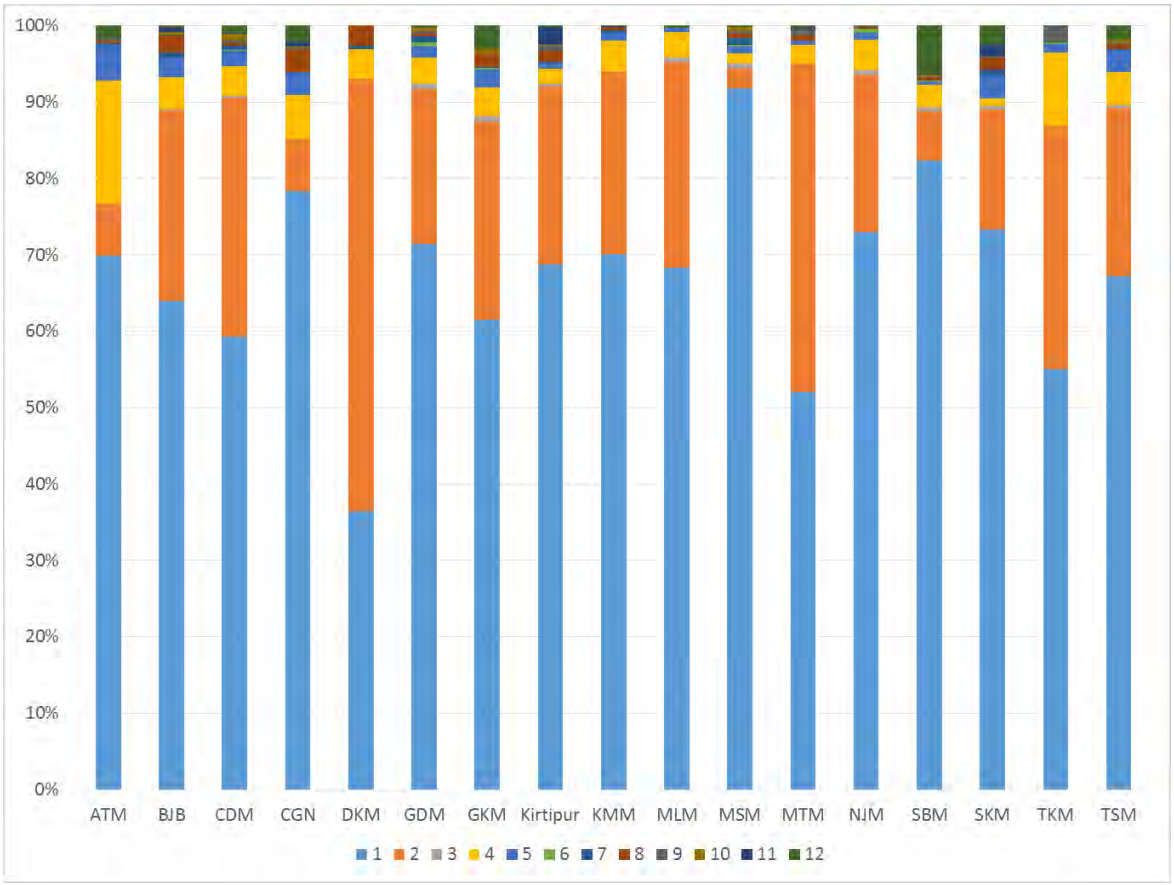


Fig. 4-13: Building Usage by Municipalities in KV.

4.5.4 CONSTRUCTION YEAR

In terms of construction period, the KV municipalities in general has about 40% of buildings are newer which has 10 years or less age. The rest of about 30% of buildings has age below 20 years. Above 50 years or old buildings are still about 6% of total buildings.

Table 4-20: Number of buildings building age in KV Municipalities.

		Construction Year					
Municipality		**1 – 10 Years**	**10 – 20 Years**	**20- 30 Years**	**30- 50 Years**	**>50 Years**	**Total**
Anantalingeshwore	ATM	237	209	63	35	14	558
Bajrabarahi	BJB	77	227	252	55	8	619
Chandragiri	CDM	491	385	135	46	10	1067
Changunarayan	CGN	302	277	84	44	11	718
Daxinkali	DKM	87	46	36	55	4	228
Godawari	GDM	307	201	69	122	61	760
Gokarneshwor	GKM	215	371	130	44	56	816
Kirtipur	Kirtipur	173	201	137	125	54	690
Kageswari-Manahara	KMM	705	283	28	14	1	1031
Mahalaxmi	MLM	257	242	72	29	18	618
Mahamanjushree	MSM	137	65	108	70	169	549
Madhyapur Thimi	MTM	202	142	103	65	36	548
Nagarjun	NJM	220	214	39	23	3	499
Suryabinayak	SBM	391	175	135	86	8	795
Shankharapur	SKM	94	89	122	69	109	483
Tokha	TKM	169	182	82	15	10	458
Tarkeshwor	TSM	307	113	51	71	46	588
Grand Total		4371	3422	1646	968	618	11025
	%	39.65	31.04	14.93	8.78	5.61	

The graph below (Fig. 4-14) shows the percentage distribution of age group in each municipalities as surveyed in KV. Kageswari Manahara Municipality shows the more than 70% of buildings are new which has 10 years or less age.

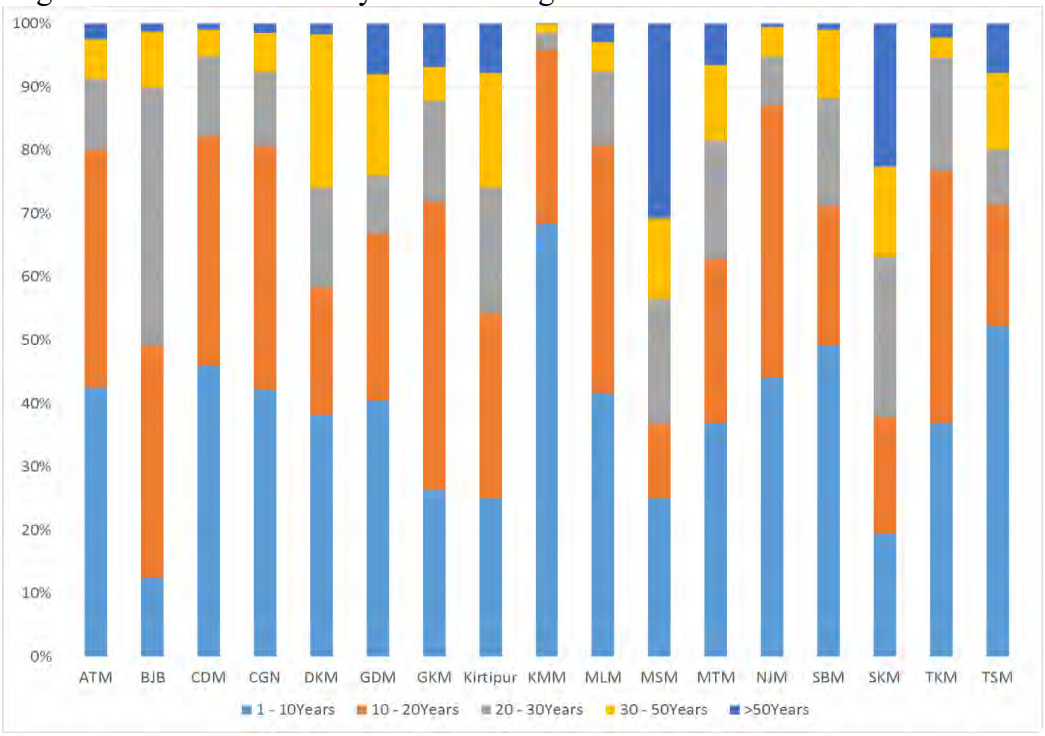


Fig. 4-14: Construction Year

4.5.5 ROOF TYPE

The majority of building roof type is rigid concrete (63%) found in Kathmandu Valley Municipalities followed by flexible wooden and CGI sheets. There is still flexible and clay roofs about 5.12 %. See Table 4-21 for detail.

Table 4-21: Roof Type Distribution in KV Municipalities.

		Roof Type			
Municipality		**Flexible, Wooden and CGI Sheet**	**Flexible, Wooden and Clay**	**Rigid Concrete**	**Total**
Anantalingeshwore	ATM	114	82	362	558
Bajrabarahi	BJB	212	50	357	619
Chandragiri	CDM	187	12	868	1067
Changunarayan	CGN	345	82	291	718
Daxinkali	DKM	80	8	140	228
Godawari	GDM	335	21	404	760
Gokarneshwor	GKM	186	14	616	816
Kirtipur	Kirtipur	173	54	463	690
Kageswari-Manahara	KMM	274	3	754	1031
Mahalaxmi	MLM	86	4	528	618
Mahamanjushree	MSM	286	123	140	549
Madhyapur Thimi	MTM	143	15	390	548
Nagarjun	NJM	67	5	427	499
Suryabinayak	SBM	294	49	452	795
Shankharapur	SKM	320	11	152	483
Tokha	TKM	84	2	372	458
Tarkeshwor	TSM	205	16	367	588
Total		3391	551	7083	11025
%		30.76	5.00	64.24	

The Fig. 4-15 shows the clear view of the majority of roofing type by municipalities in KV.

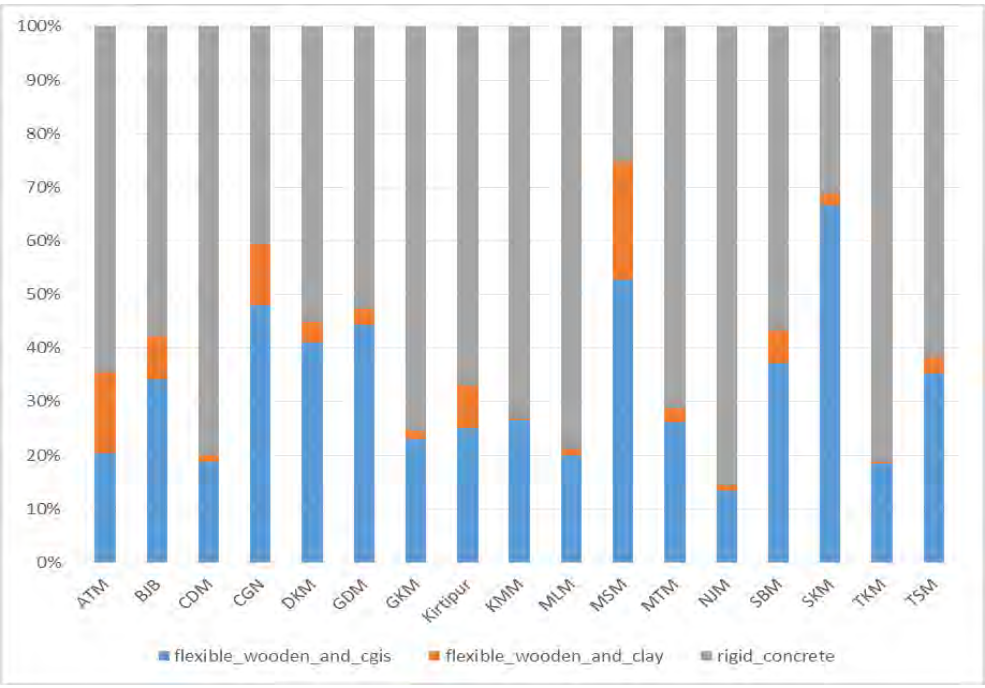


Fig. 4-15: Roof Type

4.5.6 GROUND FAILURE

Ground failure condition was not found many of municipalities. Whereas Nagarjun Municipality records 145 buildings face liquefaction out of 500 buildings surveyed, where as some case of settlement were also found in other municipalities.

Table 4-22: Ground Failure

		Ground Failure			
Municipality		**Liquefaction**	**Settlement**	**Not Found**	**Total**
Anantalingeshwore	ATM	0	2	556	558
Bajrabarahi	BJB	0	0	619	619
Chandragiri	CDM	0	2	1065	1067
Changunarayan	CGN	0	0	718	718
Daxinkali	DKM	0	0	228	228
Godawari	GDM	0	1	759	760
Gokarneshwor	GKM	0	4	812	816
Kirtipur	Kirtipur	0	3	687	690
Kageswari-Manahara	KMM	0	0	1031	1031
Mahalaxmi	MLM	0	0	618	618
Mahamanjushree	MSM	0	0	549	549
Madhyapur Thimi	MTM	0	0	548	548
Nagarjun	NJM	145	1	353	499
Suryabinayak	SBM	0	2	793	795
Shankharapur	SKM	0	0	483	483
Tokha	TKM	0	0	458	458
Tarkeshwor	TSM	0	1	587	588
Grand Total		**145**	**16**	10864	11025
%		1.29	0.13	98.58	

The table shows there is about 99 % of buildings has not such ground failure conditions in Kathmandu Valley Municipalities has noted.

4.5.7 ADJACENT BUILDINGS

About 50 % buildings are free standing and rest of building have either one or both side adjacent to the other buildings (see Table 4-23).

Table 4-23: Adjacent Buildings

		Adjacent Building			
Municipality		**Building 1 side**	**2 or more side**	**Free Standing**	**Total**
Anantalingeshwore	ATM	215	31	312	558
Bajrabarahi	BJB	206	224	189	619
Chandragiri	CDM	330	138	599	1067
Changunarayan	CGN	228	65	425	718
Daxinkali	DKM	73	130	25	228
Godawari	GDM	174	106	480	760
Gokarneshwor	GKM	269	170	377	816
Kirtipur	Kirtipur	194	310	186	690
Kageswari-Manahara	KMM	337	90	604	1031
Mahalaxmi	MLM	221	93	304	618

		Adjacent Building			
Municipality		**Building 1 side**	**2 or more side**	**Free Standing**	**Total**
Mahamanjushree	MSM	106	1	442	549
Madhyapur Thimi	MTM	159	242	147	548
Nagarjun	NJM	163	21	315	499
Suryabinayak	SBM	224	37	534	795
Shankharapur	SKM	132	105	246	483
Tokha	TKM	137	146	175	458
Tarkeshwor	TSM	208	59	321	588
Total		**3376**	**1968**	**5681**	**11025**
%		30.24	18.17	51.59	

4.5.8 LAND SLOPE

Ground condition and slope characteristics of the building (see Table 4-24) shows that more than 10% of buildings are standing on steep slopes in Kathmandu Valley. About 57% are in flat land followed by 33% in moderate slope conditions.

Table 4-24: Land Slope

		Land slope			
Municipality		**Flat Land**	**Moderate**	**Steep**	**Total**
Anantalingeshwore	ATM	468	72	18	558
Bajrabarahi	BJB	514	99	6	619
Chandragiri	CDM	389	595	83	1067
Changunarayan	CGN	480	156	82	718
Daxinkali	DKM	197	30	1	228
Godawari	GDM	699	57	4	760
Gokarneshwor	GKM	412	388	16	816
Kirtipur	Kirtipur	227	362	101	690
Kageswari-Manahara	KMM	547	484	0	1031
Mahalaxmi	MLM	144	419	55	618
Mahamanjushree	MSM	103	221	225	549
Madhyapur Thimi	MTM	518	30	0	548
Nagarjun	NJM	289	128	82	499
Suryabinayak	SBM	270	241	284	795
Shankharapur	SKM	193	205	85	483
Tokha	TKM	296	159	3	458
Tarkeshwor	TSM	459	95	34	588
Total		**6205**	**3741**	**1079**	**11025**
%		56.61	33.24	10.15	

4.5.9 IRREGULARITY

Municipal distribution of buildings by Irregularity type is shown in following Table 4-25a.

Table 4-8: Municipal distribution of buildings by structural type

Municipality		Overhang	Regular	Soft Storey	Grand Total
Anantalingeshwore	ATM	10	515	33	558
Bajrabarahi	BJB	19	543	57	619
Chandragiri	CDM	116	887	64	1067
Changunarayan	CGN	3	697	18	718
Daxinkali	DKM	1	227	0	228
Godawari	GDM	2	750	8	760
Gokarneshwor	GKM	59	742	15	816
Kirtipur	KRT	14	667	9	690
Kageswari-Manahara	KMM	36	948	47	1031
Mahalaxmi	MLM	6	560	52	618
Mahamanjushree	MSM	0	540	9	549
Madhyapur Thimi	MTM	39	486	23	548
Nagarjun	NJM	36	383	80	499
Suryabinayak	SBM	8	786	1	795
Shankharapur	SKM	0	473	10	483
Tokha	TKM	37	407	14	458
Tarkeshwor	TSM	45	526	17	588
Grand Total		**431**	**10137**	**457**	11025
%		**3.8**	**92.1**	**4**	

4.5.10 PERCENTAGE OF IRREGULARITY FOR STRUCTURE TYPE 6 AND 7

The following table (Table 4-25) has been prepared to see the relationship of certain characteristics of the building with relation with the special structural types of buildings in Kathmandu Valley Municipalities.

Table 4-25: Building Irregularity and Structural type 6 and 7 relationship in KV Municipalities

Municipality Area	Overhang and Soft-storey	Regular	Total
ATM (Anantalingeshwore)	11.04%	**88.96%**	
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	12.41%	87.59%	100.0%
BJB (Bajrabarahi)	25.60%	**74.40%**	
RCFrame_enginnered	50.00%	50.00%	100.0%
RCFrame_non_enginnered	25.37%	74.63%	100.0%
CDM (Chandragiri)	19.41%	**80.59%**	
RCFrame_enginnered	3.05%	96.95%	100.0%
RCFrame_non_enginnered	24.95%	75.05%	100.0%
CGN (Changunarayan)	3.52%	**96.48%**	
RCFrame_enginnered	5.88%	94.12%	100.0%
RCFrame_non_enginnered	3.35%	96.65%	100.0%
DKM (Daxinkali)	0.00%	**100.00%**	
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	0.00%	100.00%	100.0%
GDM (Godawari)	1.72%	**98.28%**	
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	1.91%	98.09%	100.0%
GKM (Gokarneshwore)	19.57%	**80.43%**	
RCFrame_enginnered	20.00%	80.00%	100.0%
RCFrame_non_enginnered	19.53%	80.47%	100.0%
Kirtipur	6.25%	**93.75%**	

Municipality Area	Overhang and Soft-storey	Regular	Total
RCFrame_enginnered	5.88%	94.12%	100.0%
RCFrame_non_enginnered	6.29%	93.71%	100.0%
KMM (Kageshwari-Manahara)	11.83%	**88.17%**	
RCFrame_enginnered	5.69%	94.31%	100.0%
RCFrame_non_enginnered	13.36%	86.64%	100.0%
MLM (Mahalaxmi)	10.90%	**89.10%**	
RCFrame_enginnered	9.80%	90.20%	100.0%
RCFrame_non_enginnered	11.03%	88.97%	100.0%
MSM (Mahamanjushree - Nagarkot)	5.83%	**94.17%**	
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	6.32%	93.68%	100.0%
MTM (Madhyapur Thimi)	16.36%	**83.64%**	
RCFrame_enginnered	7.69%	92.31%	100.0%
RCFrame_non_enginnered	16.72%	83.28%	100.0%
NJM (Nagarjun)	29.32%	**70.68%**	
RCFrame_enginnered	38.89%	61.11%	100.0%
RCFrame_non_enginnered	28.82%	71.18%	100.0%
SBM (Suryabinayak)	1.81%	**98.19%**	
RCFrame_enginnered	4.35%	95.65%	100.0%
RCFrame_non_enginnered	1.65%	98.35%	100.0%
SKM (Shankharapur)	3.74%	**96.26%**	
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	4.94%	95.06%	100.0%
TKM (Tokha)	12.57%	**87.43%**	
RCFrame_enginnered	23.81%	76.19%	100.0%
RCFrame_non_enginnered	11.82%	88.18%	100.0%
TSM (Tarkeshowor)	17.85%	**82.15%**	
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	18.18%	81.82%	100.0%
Total	13.28%	**86.72%**	**100.0%**

The overall about 87% of buildings are regular in shape, the rest of 13 % buildings found either soft-storey (6% has soft-storey) or/and overhang properties (about 7%) found during the survey.

4.5.11 Percentage of Roof Type for Structure Type 4 and 5

The relationship between roof type and building typology 4 and 5 has been shown in the following Table 4-26.

Table 4-26: Building Irregularity and Structural type 6 and 7 relationship in KV Municipalities

Municipality	Flexible (wooden&cgis)	Flexible (wooden &clay)	Rigid Concrete	Total
ATM (Anantalingeshwore)	**25.14%**	**44.57%**	**30.29%**	
Brick_with_cement_mortar	37.97%	6.33%	55.70%	100.00%
Brick_with_Mud_mortar	14.58%	76.04%	9.38%	100.00%
BJB (Bajrabarahi)	**46.40%**	**13.07%**	**40.53%**	
Brick_with_cement_mortar	22.44%	3.21%	74.36%	100.00%
Brick_with_Mud_mortar	63.47%	20.09%	16.44%	100.00%
CDM (Chandragiri)	**34.35%**	**1.11%**	**64.54%**	
Brick_with_cement_mortar	27.18%	0.34%	72.48%	100.00%
Brick_with_Mud_mortar	68.25%	4.76%	26.98%	100.00%

Municipality	Flexible (wooden&cgis)	Flexible (wooden &clay)	Rigid Concrete	Total
CGN (Changunarayan)	**62.50%**	**20.51%**	**16.99%**	
Brick_with_cement_mortar	45.33%	4.00%	50.67%	100.00%
Brick_with_Mud_mortar	67.93%	25.74%	6.33%	100.00%
DKM (Daxinkali)	**57.35%**	**5.88%**	**36.76%**	
Brick_with_cement_mortar	21.05%	0.00%	78.95%	100.00%
Brick_with_Mud_mortar	83.54%	10.13%	6.33%	100.00%
GDM (Godawari)	**52.48%**	**3.47%**	**44.06%**	
Brick_with_cement_mortar	27.47%	0.43%	72.10%	100.00%
Brick_with_Mud_mortar	86.55%	7.60%	5.85%	100.00%
GKM (Gokarneshwor)	**29.33%**	**3.23%**	**67.44%**	
Brick_with_cement_mortar	10.81%	0.68%	88.51%	100.00%
Brick_with_Mud_mortar	69.34%	8.76%	21.90%	100.00%
Kirtipur	**30.91%**	**11.04%**	**58.06%**	
Brick_with_cement_mortar	11.97%	2.32%	85.71%	100.00%
Brick_with_Mud_mortar	56.19%	22.68%	21.13%	100.00%
KMM (Kageshwori Manahara)	**42.80%**	**0.40%**	**56.80%**	
Brick_with_cement_mortar	20.35%	0.00%	79.65%	100.00%
Brick_with_Mud_mortar	92.31%	1.28%	6.41%	100.00%
MLM (Mahalaxmi)	**49.59%**	**2.44%**	**47.97%**	
Brick_with_cement_mortar	29.69%	0.00%	70.31%	100.00%
Brick_with_Mud_mortar	71.19%	5.08%	23.73%	100.00%
MSM (Mahamanjushree-Nagarkot)	**59.81%**	**23.36%**	**16.82%**	
Brick_with_cement_mortar	41.46%	2.44%	56.10%	100.00%
Brick_with_Mud_mortar	64.16%	28.32%	7.51%	100.00%
MTM (Madhyapur Thimi)	**62.67%**	**6.91%**	**30.41%**	
Brick_with_cement_mortar	40.48%	4.76%	54.76%	100.00%
Brick_with_Mud_mortar	76.69%	8.27%	15.04%	100.00%
NJM (Nagarjun)	**46.15%**	**3.85%**	**50.00%**	
Brick_with_cement_mortar	23.68%	0.00%	76.32%	100.00%
Brick_with_Mud_mortar	77.78%	9.26%	12.96%	100.00%
SBM (Suryabinayak)	**58.46%**	**6.15%**	**35.38%**	
Brick_with_cement_mortar	30.12%	1.20%	68.67%	100.00%
Brick_with_Mud_mortar	79.46%	9.82%	10.71%	100.00%
SKM (Shankharapur)	**77.19%**	**0.88%**	**21.93%**	
Brick_with_cement_mortar	40.85%	0.00%	59.15%	100.00%
Brick_with_Mud_mortar	93.63%	1.27%	5.10%	100.00%
TKM (Tokha)	**50.00%**	**1.16%**	**48.84%**	
Brick_with_cement_mortar	27.91%	0.00%	72.09%	100.00%
Brick_with_Mud_mortar	72.09%	2.33%	25.58%	100.00%
TSM (Tarakeshowor)	**56.20%**	**6.57%**	**37.23%**	
Brick_with_cement_mortar	41.86%	1.16%	56.98%	100.00%
Brick_with_Mud_mortar	80.39%	15.69%	3.92%	100.00%

Municipality	Flexible (wooden&cgis)	Flexible (wooden &clay)	Rigid Concrete	Total
Grand Total	**47.20%**	**8.96%**	**43.84%**	**100.00%**

4.5.12 DAMAGE TO BUILDINGS

Similar to other municipalities in KV, majority of building damage was under Grade 1 damage category 73 %. Damage grade 5 buildings found about 5.6 % followed by damage grade 4 (about 4.8%). Gokarneshwor, Mahalaxmi, Shankharapur, Kageshwari-Mahanara Municipalities has greater loss in terms of damage grade.

Table 4-27: Building Damage Grade by Municipalities in Kathmandu Valley

		Damage Grade (DG)					
Municipalities		**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**	**Total**
Anantalingeshwore	ATM	450	35	22	40	11	558
Bajrabarahi	BJB	452	82	43	16	26	619
Chandragiri	CDM	945	57	29	18	18	1067
Changunarayan	CGN	482	108	52	32	44	718
Daxinkali	DKM	155	36	27	9	1	228
Godawari	GDM	492	87	107	42	32	760
Gokarneshwor	GKM	656	68	18	11	63	816
Kirtipur	Kirtipur	473	99	46	52	20	690
Kageswari-Manahara	KMM	778	54	34	40	125	1031
Mahalaxmi	MLM	529	37	27	24	1	618
Mahamanjushree	MSM	298	114	43	27	67	549
Madhyapur Thimi	MTM	520	19	4	3	2	548
Nagarjun	NJM	413	28	13	20	25	499
Suryabinayak	SBM	566	83	93	23	30	795
Shankharapur	SKM	198	104	48	75	58	483
Tokha	TKM	395	26	8	6	23	458
Tarkeshwor	TSM	394	41	38	61	54	588
Total		8196	1078	652	499	600	11025
%		74.34	9.78	5.91	4.53	5.44	

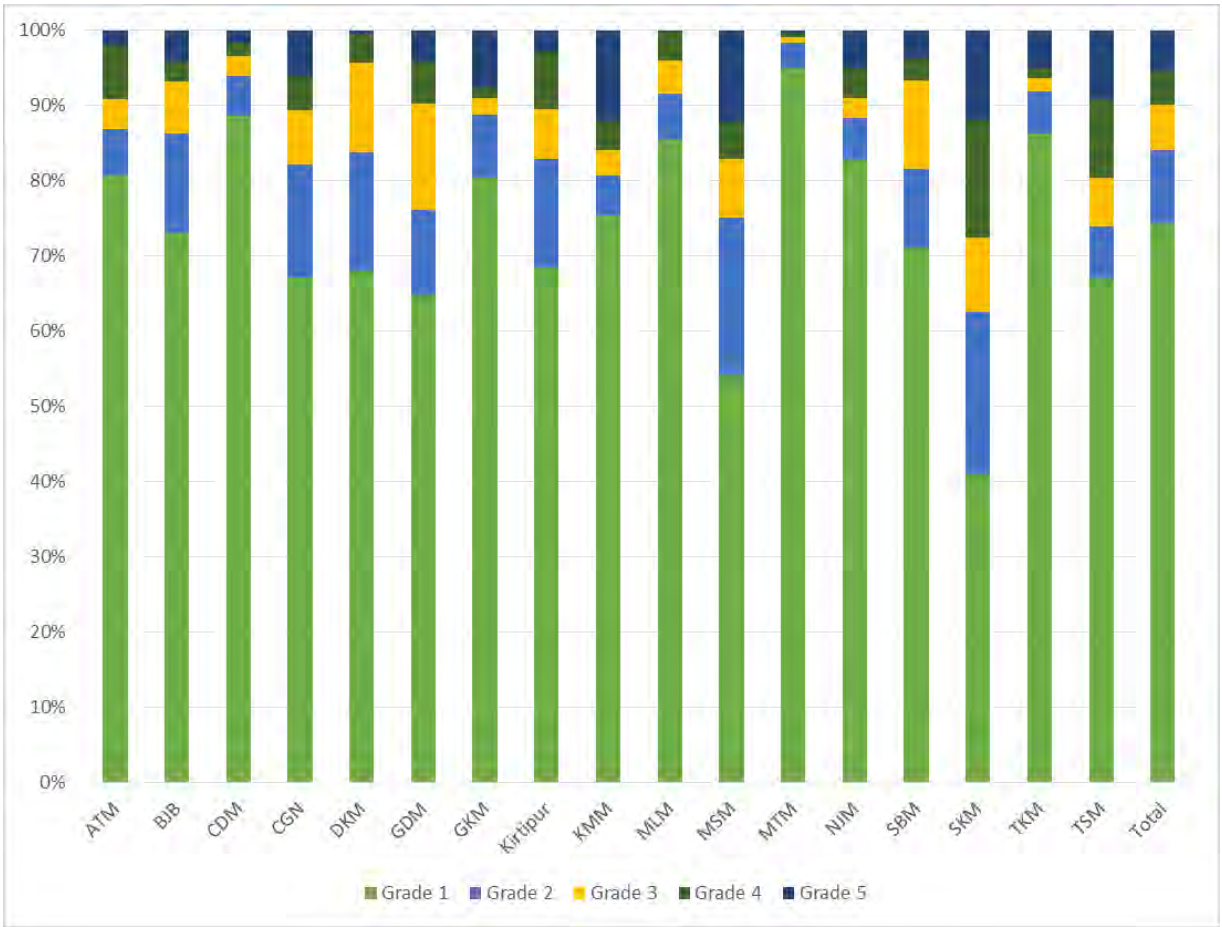


Fig. 4-16: Damage Grade by Municipalities in KV.

4.6 Damage Degree and Structural Type

Further to damage degree by structural type shows the result of 2015 Gorkha Earthquake that majority of building damage was under Grade 1 damage category 73 %. Damage grade 5 buildings found about 5.6 % followed by damage grade 4 (about 4.8%). By municipalities Gokarneshowr, Mahalaxmi, Shankharapur, Kageshwari-Manahara Municipalities has greater loss in terms of damage grade 5. The following table (Table 4-28) shows the total number of buildings damage under different damage grade in relation to structural type

Table 4-28: Damage Grade by Settlements in Municipalities of KV.

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total
ATM Anantalingeshwore	**450**	**35**	**22**	**40**	**11**	**558**
Stone with Mud Mortar	0	0	2	0	0	2
Stone with Cement Mortar	5	0	0	0	0	5
Brick with Mud Mortar	17	17	16	35	11	96
Brick with Cement Mortar	65	7	4	3	0	79
RC Frame NonEng	270	10	0	2	0	282
RC Frame Eng	34	1	0	0	0	35
Other	59	0	0	0	0	59
BJB Bajrabarahi	**452**	**82**	**43**	**16**	**26**	**619**
Adobe	2	1	0	0	0	3
Stone with Mud Mortar	16	2	0	1	2	21
Stone with Cement Mortar	2	0	0	0	0	2
Brick with Mud Mortar	115	27	39	14	24	219

Brick with Cement Mortar	111	42	2	1	0	156
RC Frame NonEng	195	9	1	0	0	205
RC Frame Eng	2	0	0	0	0	2
Other	9	1	1	0	0	11
CDM Chandragiri	**945**	**57**	**29**	**18**	**18**	**1067**
Adobe	2	1	2	3	2	10
Stone with Mud Mortar	2	6	7	6	15	36
Stone with Cement Mortar	6	0	1	1	0	8
Brick with Mud Mortar	25	18	15	4	1	63
Brick with Cement Mortar	273	19	3	3	0	298
RC Frame NonEng	470	13	1	1	0	485
RC Frame Eng	164	0	0	0	0	164
Other	3	0	0	0	0	3
CGN Changunarayan	**482**	**108**	**52**	**32**	**44**	**718**
Adobe	17	11	19	12	13	72
Stone with Mud Mortar	1	15	4	3	2	25
Stone with Cement Mortar	2	0	0	0	0	2
Brick with Mud Mortar	116	53	25	15	28	237
Brick with Cement Mortar	63	9	1	2	0	75
RC Frame NonEng	233	3	2	0	1	239
RC Frame Eng	17	0	0	0	0	17
Other	33	17	1	0	0	51
DKM Daxinkali	**155**	**36**	**27**	**9**	**1**	**228**
Adobe	0	0	1	0	0	1
Stone with Cement Mortar	1	0	0	0	0	1
Brick with Mud Mortar	8	35	26	9	1	79
Brick with Cement Mortar	56	1	0	0	0	57
RC Frame NonEng	85	0	0	0	0	85
RC Frame Eng	5	0	0	0	0	5
GDM Godawari	**492**	**87**	**107**	**42**	**32**	**760**
Adobe	2	6	26	12	9	55
Stone with Mud Mortar	7	12	20	5	8	52
Stone with Cement Mortar	7	1	3	1	0	12
Brick with Mud Mortar	37	49	50	23	12	171
Brick with Cement Mortar	210	14	7	0	2	233
RC Frame NonEng	202	5	0	1	1	209
RC Frame Eng	23	0	0	0	0	23
Other	4	0	1	0	0	5
GKM Gokarneshwor	**656**	**68**	**18**	**11**	**63**	**816**
Adobe	5	7	2	0	0	14
Stone with Mud Mortar	5	4	2	6	21	38
Stone with Cement Mortar	5	1	0	0	0	6
Brick with Mud Mortar	66	17	12	4	38	137
Brick with Cement Mortar	258	31	2	1	4	296
RC Frame NonEng	290	7	0	0	0	297
RC Frame Eng	24	1	0	0	0	25

Other	3	0	0	0	0	3
Kirtipur	**473**	**99**	**46**	**52**	**20**	**690**
Adobe	0	1	0	9	2	12
Stone with Mud Mortar	11	8	3	5	2	29
Stone with Cement Mortar	2	0	0	0	0	2
Brick with Mud Mortar	33	70	41	36	14	194
Brick with Cement Mortar	235	19	2	2	1	259
RC Frame NonEng	174	1	0	0	0	175
RC Frame Eng	17	0	0	0	0	17
Other	1	0	0	0	1	2
KMM Kageshwori Manahara	**778**	**54**	**34**	**40**	**125**	**1031**
Adobe	6	6	7	5	32	56
Stone with Mud Mortar	3	5	6	22	62	98
Stone with Cement Mortar	2	0	1	0	0	3
Brick with Mud Mortar	24	12	12	9	21	78
Brick with Cement Mortar	143	13	6	4	6	172
RC Frame NonEng	472	17	1	0	4	494
RC Frame Eng	121	1	1	0	0	123
Other	7	0	0	0	0	7
MLM Mahalaxmi	**529**	**37**	**27**	**24**	**1**	**633**
Adobe	0	0	6	9	1	16
Stone with Mud Mortar	0	0	2	0	0	2
Brick with Mud Mortar	7	21	17	14	0	59
Brick with Cement Mortar	55	6	2	1	0	64
RC Frame NonEng	416	10	0	0	0	426
RC Frame Eng	51	0	0	0	0	51
MSM Mahamanjushree-Nagarkot	**298**	**114**	**43**	**27**	**67**	**549**
Adobe	38	27	14	6	21	106
Stone with Mud Mortar	7	11	10	10	10	48
Stone with Cement Mortar	9	6	2	2	3	22
Brick with Mud Mortar	63	60	15	9	26	173
Brick with Cement Mortar	34	4	1	0	2	41
RC Frame NonEng	90	4	1	0	0	95
RC Frame Eng	8	0	0	0	0	8
Other	49	2	0	0	5	56
MTM Madhyapur Thimi	**520**	**19**	**4**	**3**	**2**	**548**
Brick with Mud Mortar	107	17	4	3	2	133
Brick with Cement Mortar	82	2	0	0	0	84
RC Frame NonEng	317	0	0	0	0	317
RC Frame Eng	13	0	0	0	0	13
Other	1	0	0	0	0	1
NJM Nagarjun	**413**	**28**	**13**	**20**	**25**	**499**
Stone with Mud Mortar	0	0	0	0	2	2
Stone with Cement Mortar	1	0	0	0	0	1
Brick with Mud Mortar	14	3	2	14	21	54
Brick with Cement Mortar	59	6	5	4	2	76

RC Frame NonEng	321	19	5	2	0	347
RC Frame Eng	18	0	0	0	0	18
Other	0	0	1	0	0	1
SBM Suryabinayak	**566**	**83**	**93**	**23**	**30**	**795**
Adobe	22	25	36	8	10	101
Stone with Mud Mortar	3	13	28	10	17	71
Stone with Cement Mortar	3	0	0	0	0	3
Brick with Mud Mortar	64	19	22	4	3	112
Brick with Cement Mortar	66	12	5	0	0	83
RC Frame NonEng	351	9	2	1	0	363
RC Frame Eng	23	0	0	0	0	23
Other	34	5	0	0	0	39
SKM Shankharapur	**198**	**104**	**48**	**75**	**58**	**483**
Adobe	7	58	26	16	10	117
Stone with Mud Mortar	4	7	1	1	2	15
Stone with Cement Mortar	0	0	0	0	1	1
Brick with Mud Mortar	14	27	17	54	45	157
Brick with Cement Mortar	57	8	2	4	0	71
RC Frame NonEng	79	1	1	0	0	81
RC Frame Eng	25	0	1	0	0	26
Other	12	3	0	0	0	15
TKM Tokha	**395**	**26**	**8**	**6**	**23**	**458**
Adobe	3	6	1	2	1	13
Stone with Mud Mortar	3	3	0	2	14	22
Stone with Cement Mortar	2	1	0	0	0	3
Brick with Mud Mortar	20	8	6	1	8	43
Brick with Cement Mortar	38	4	1	0	0	43
RC Frame NonEng	308	4	0	1	0	313
RC Frame Eng	21	0	0	0	0	21
TSM Tarkeshwor	**394**	**41**	**38**	**61**	**54**	**588**
Adobe	5	9	23	38	37	112
Stone with Mud Mortar	0	2	3	1	3	9
Stone with Cement Mortar	0	1	0	0	1	2
Brick with Mud Mortar	6	7	9	16	13	51
Brick with Cement Mortar	66	13	3	4	0	86
RC Frame NonEng	308	9	0	2	0	319
RC Frame Eng	6	0	0	0	0	6
Other	3	0	0	0	0	3
Grand Total	**8196**	**1078**	**652**	**499**	**600**	**11025**

ACTIVITY 3: BUILDING SURVEY OUTSIDE KATHMANDU VALLEY

The scope of work for Activity 3 was specified as the survey of sample buildings outside the Kathmandu Valley (outside KV) in selected municipalities. Each Municipality was supposed to survey approximately 100-200 buildings totaling 1,000 buildings. Total number of buildings surveyed for this activity was 1,468. This section of report presents summary of the data carried out under this activity.

4.7 BUILDING SURVEY

Table 4-29: Municipalities selected for survey outside KV.

SN	Municipality/VDC	# of Buildings Surveyed	SN	Municipality/VDC	# of Buildings Surveyed
1	Bidur	149	6	Nilakantha	175
2	Dhunche VDC	209	7	Palungtar	173
3	Gerkhu VDC	57	8	Panchkal	317
4	Gorkha	183	9	Thaha	110
5	Lahare Pauwa	61		**Grand Total**	**1,434**

Refer Map 4-2 for the location of Municipalities and VDCs taken into consideration for the survey. Two village development committees (VDC settlement with higher population density, and urban in nature) were also selected for the survey in Rasuwa District (i.e. Gerkhu, Lahare pauwa and Dhunche VDCs).

4.7.1 NUMBER OF STORIES

The majority of buildings are two storied buildings outside the KV, followed by single storied buildings (see Table 4-30, and Fig. 4-17.)

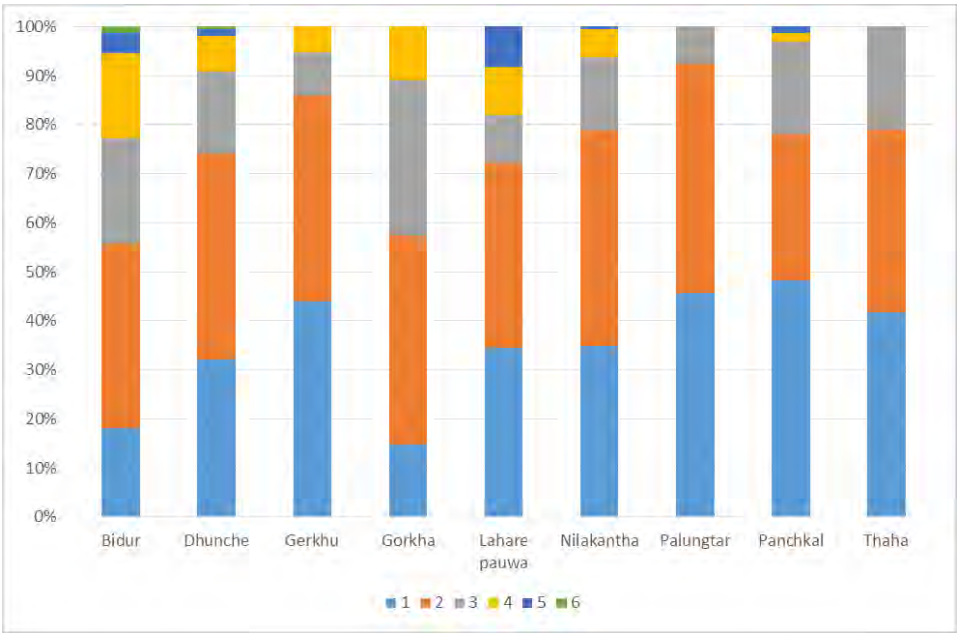


Fig. 4-17: Number of stories by municipalities outside KV.

Table 4-30: Number of stories by municipalities outside KV.

	No of stories						
	1	**2**	**3**	**4**	**5**	**6**	**Total**
Bidur	27	56	32	26	6	2	149
Dhunche	67	88	35	15	3	1	209
Gerkhu	25	24	5	3	0	0	57
Gorkha	27	78	58	20	0	0	183
Lahare pauwa	21	23	6	6	5	0	61
Nilakantha	61	77	26	10	1	0	175
Palungtar	79	81	13	0	0	0	173
Panchkal	153	94	60	6	4	0	317
Thaha	46	41	23	**0**	**0**	**0**	110
Total	506	562	258	86	19	3	1434
%	35.3	39.2	18.0	6.0	1.3	0.2	

4.7.2 STRUCTURAL TYPE

Major structural type of buildings outside KV Municipalities has dominance of stone in mud mortar Stone in Mud Mortar (28%), followed by RC Frame Non-Engineered (27%). Only 2% buildings are RC Frame Engineered.

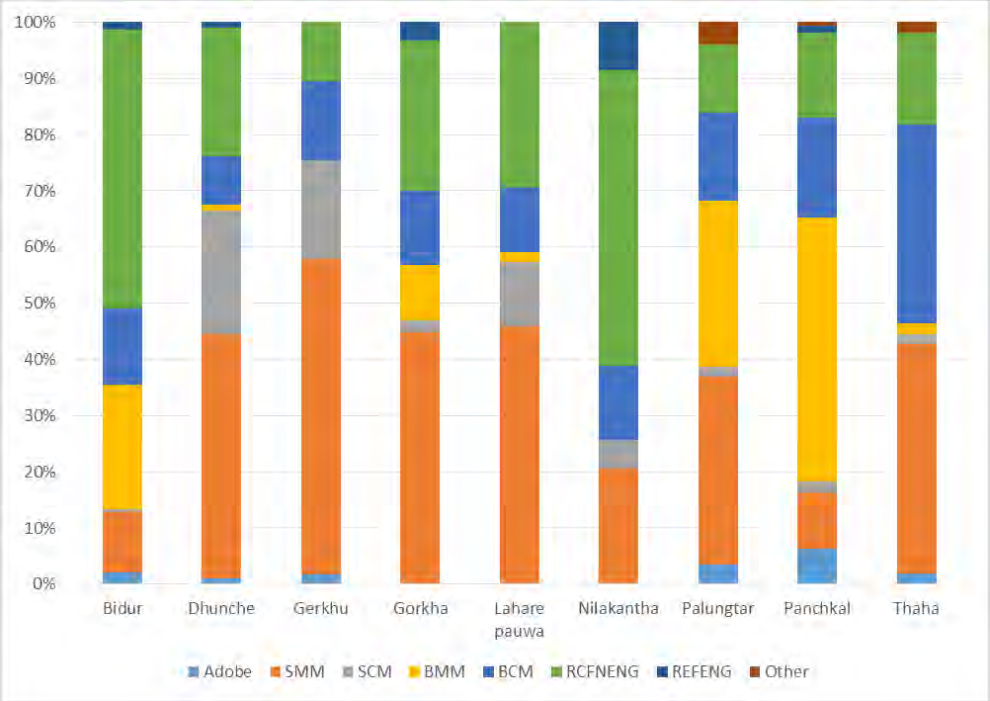


Fig. 4-18: Distribution of Buildings by Structural Types by Municipalities outside KV.

For outside the KV municipalities, the majority of buildings are found RC Frame Non-Engineered (see table 4-31).

Table 4-31: Distribution of Buildings by Structural Types by Municipalities outside KV.

	Structure Type								
Municipalities	**Adobe**	**SMM**	**SCM**	**BMM**	**BCM**	**RCFNENG**	**REFENG**	**Other**	**Total**
Bidur	3	16	1	33	20	74	2	0	149
Dhunche	2	91	46	2	18	48	2	0	209
Gerkhu	1	32	10	0	8	6	0	0	57
Gorkha	0	82	4	18	24	49	6	0	183
Lahare pauwa	0	28	7	1	7	18	0	0	61
Nilakantha	0	36	9	0	23	92	15	0	175

Palungtar	6	58	3	51	27	21	0	7	173
Panchkal	20	32	6	149	56	48	4	2	317
Thaha	2	45	2	2	39	18	0	2	110
Total	34	420	88	256	222	374	29	11	1434

Where, BCM = Brick in Cement mortar, BMM= Brick in Mud Mortar, SCM= Stone in Cement Mortar, SMM= Stone in Mud Mortar RC Frame (Eng) = Engineered Designed RC Frame, RC Frame (NonEng)= Non Engineered RCFrame Structure,

4.7.3 USAGE

As in other municipalities, the majority of buildings are definitely used for the residential purpose followed by residential & shop at GFL category. The commercial purpose buildings are about 3.5% of total buildings.

Table 4-32: Distribution of Buildings Usage by Municipalities outside KV.

	Building Usage												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Bidur	43	86	1	8	1	1	5	2	2	0	0	0	149
Dhunche	83	61	14	10	7	2	23	5	2	0	0	2	209
Gerkhu	33	22	0	0	0	0	0	0	0	0	0	2	57
Gorkha	117	52	1	2	5	0	1	2	0	0	3	0	183
Lahare pauwa	25	28		3	2	0	1	2	0	0	0	0	61
Nilakantha	94	66	1	3	4	0	0	2	0		5		175
Palungtar	138	25	1	1	2	0	0	1	0	2	0	3	173
Panchkal	207	44	8	24	8	0	2	0	0	2	8	14	317
Thaha	58	21	2	3	10	0	2	7	5			2	110
Total	798	405	28	54	39	3	34	21	9	4	16	23	1434

Where 1= Residence, 2= Residence & shop at GFL, 3= Office, 4=Commercial, 5= Education, 6= Hospital, 7= Governmental, 8= Historical & Temple, 9= Hotel & Restaurant, 10= Industry, 11= Assembly, 12= others

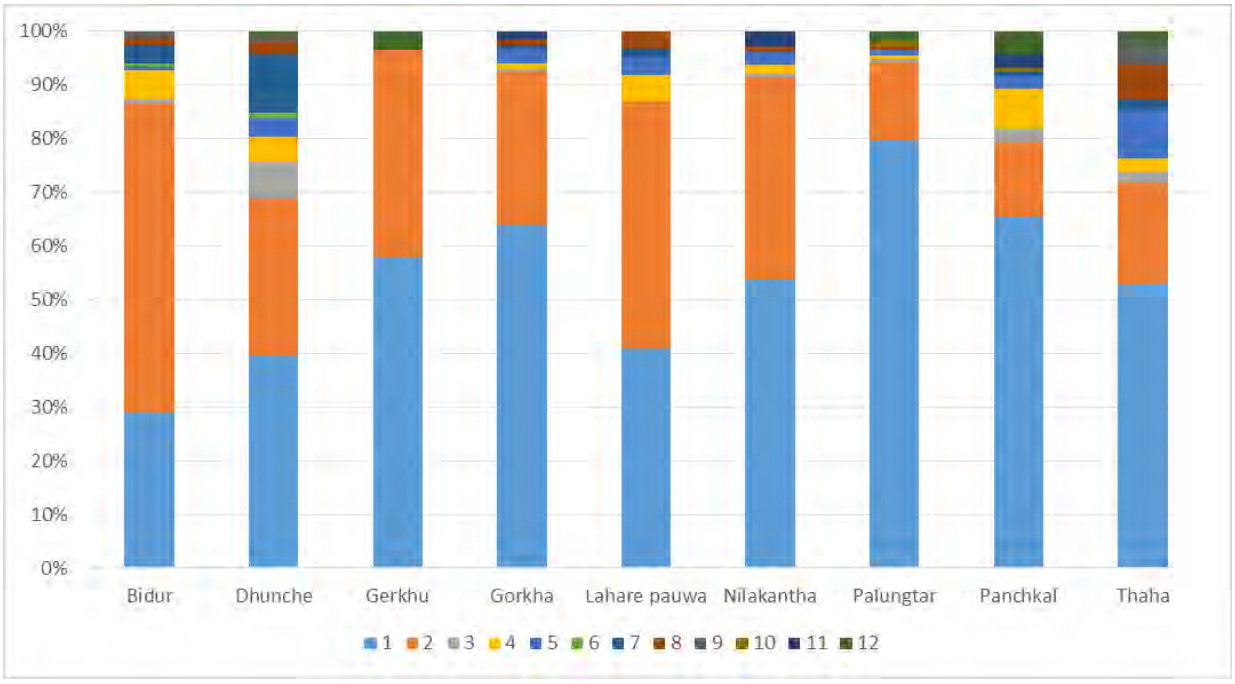


Fig. 4-19: Distribution of Buildings Usage by Municipalities outside KV.

4.7.4 CONSTRUCTION YEAR

According to the survey, the dominance of buildings are age category under under 10 years, followed by under 20 years of age about equal proportion of the total building (about 26% each). About 7.5 %of buildings are 50 years or older.

Table 4-33: Buildings Age by Municipalities outside KV.

	Construction Year					
Municipalities	**1 - 10Years**	**10 - 20Years**	**20- 30Years**	**30 - 50Years**	**>50Years**	**Total**
Bidur	15	53	60	18	3	149
Dhunche	42	70	61	28	8	209
Gerkhu	4	14	32	7		57
Gorkha	41	48	37	33	24	183
Lahare pauwa	8	14	16	11	12	61
Nilakantha	106	36	8	18	7	175
Palungtar	59	45	37	27	5	173
Panchkal	48	70	52	95	52	317
Thaha	34	29	24	17	6	110
Total	**357**	**379**	**327**	**254**	**117**	**1434**

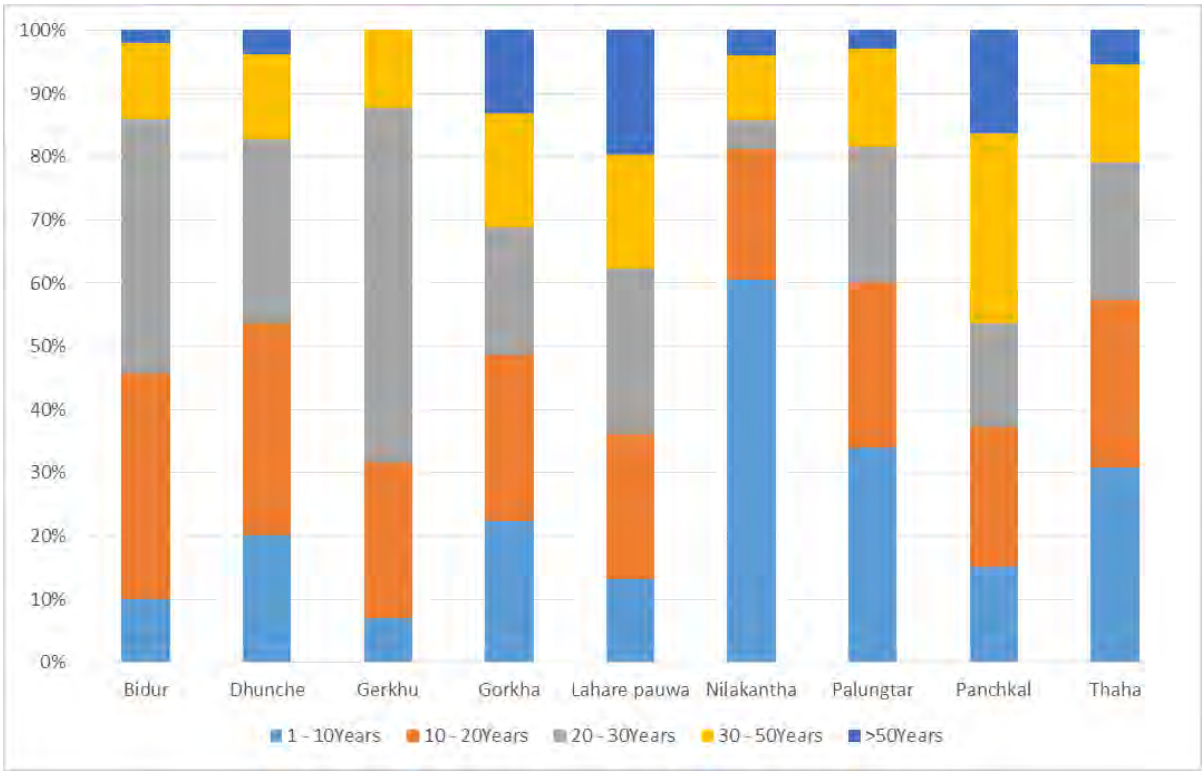


Fig. 4-20: Buildings Age by Municipalities outside KV.

4.7.5 ROOF TYPE

The dominance roof type is flexible wooden and CGI sheet followed by rigid concrete in municipalities in outside the KV. About 6.5 % buildings have flexible wooden and clay roofs.

Table 4-34: Buildings distribution by Roof Type in Municipalities outside KV.

	Roof Type			
Municipalities	**Flexible Wooden and CGI Sheet**	**Flexible Wooden and Clay**	**Rigid Concrete**	**Total**
Bidur	50	3	96	149

Dhunche	125	0	84	209
Gerkhu	40	0	17	57
Gorkha	85	22	76	183
Lahare pauwa	32	1	28	61
Nilakantha	47	14	114	175
Palungtar	130	32	11	173
Panchkal	225	22	70	317
Thaha	70	3	37	110
Total	**804**	**97**	**533**	**1434**

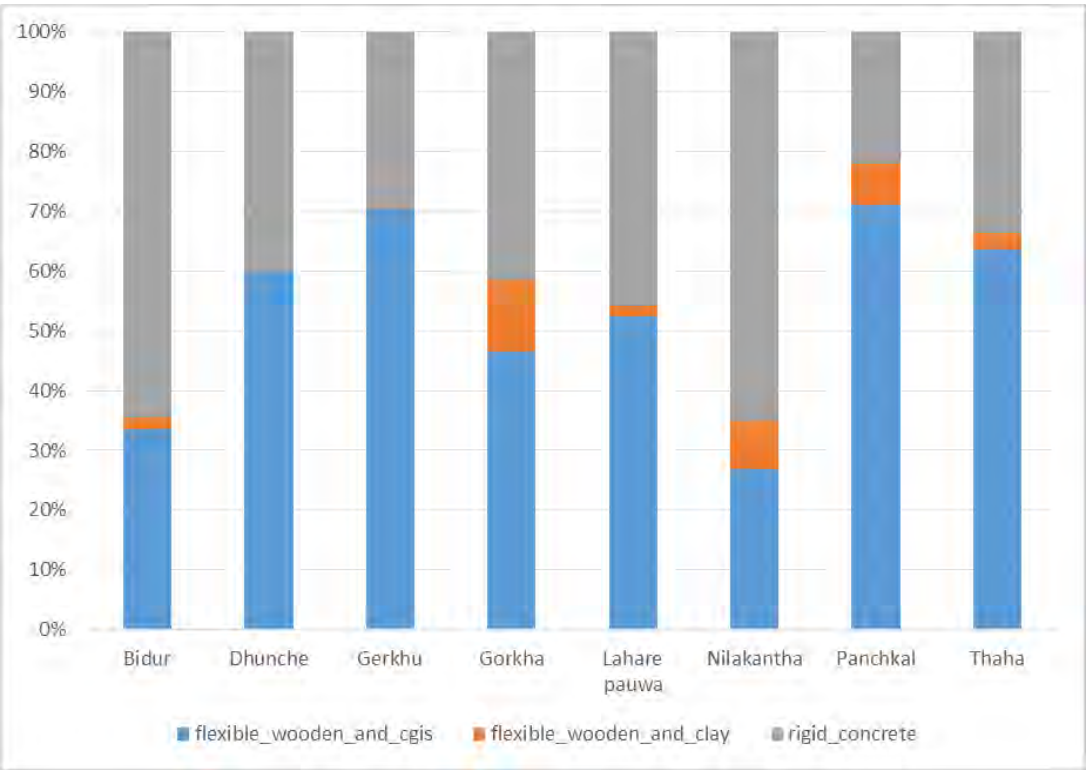


Fig. 4-21: Buildings distribution by roof type in Municipalities outside KV.

4.7.6 GROUND FAILURE

Ground failure cases were found in some buildings in Gorkha Municipalities which is settlement of buildings. In Panchkhal and Nilkantha municipalities only one case each were recorded by surveyors. There are no other cases of landslide and liquefaction outside KV survey.

Table 4-35: Ground failure records in building survey in municipalities outside KV.

VDC/ Municipalities	Ground failure			
	Not found	Settlement	Landslide	Total
Bidur	149	0	0	149
Dhunche	209	0	0	209
Gerkhu	57	0	0	57
Gorkha	172	11	0	183
Lahare pauwa	61	0	0	61
Nilakantha	174	1	0	175
Palungtar	173	0	0	173
Panchkal	315	2	0	317
Thaha	110	0	**0**	110
Grand Total	**1420**	**14**	0.00	**1434**

4.7.7 ADJACENT BUILDINGS

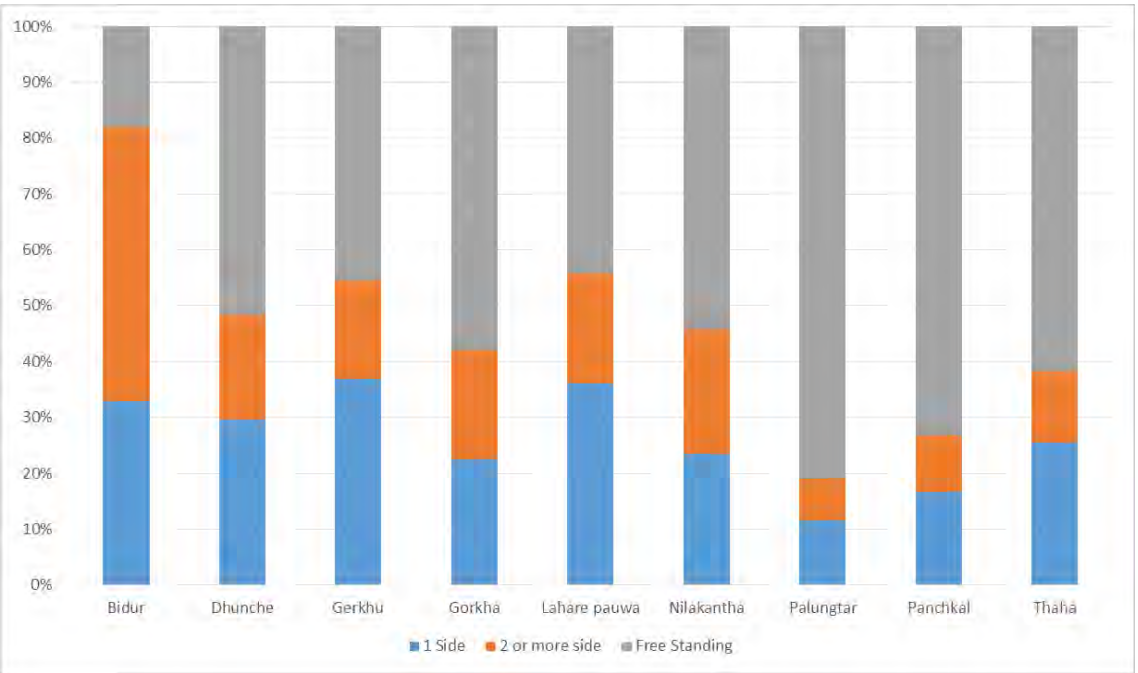


Table 4-36: Buildings distribution by Adjacent Buildingin Municipalities outside KV

	Adjacent Building			
Municipalities	**1 Side**	**2 or more side**	**Free Standing**	**Total**
Bidur	49	73	27	149
Dhunche	62	39	108	209
Gerkhu	21	10	26	57
Gorkha	41	36	106	183
Lahare pauwa	22	12	27	61
Nilakantha	41	39	95	175
Palungtar	20	13	140	173
Panchkal	53	32	232	317
Thaha	28	14	68	110
Grand Total	**337**	**268**	**829**	**1434**

4.7.8 LAND SLOPE

Table 4-37: Land slope by municipalities outside KV

	Land slope			
Municipalities	**Flat**	**Moderate**	**Steep**	**Total**
Bidur	89	36	24	149
Dhunche	0	75	134	209
Gerkhu	0	44	13	57
Gorkha	8	71	104	183
Lahare pauwa	22	30	9	61
Nilakantha	44	54	77	175
Palungtar	130	42	1	173
Panchkal	62	203	52	317
Thaha	68	25	17	110
Total	**423**	**580**	**431**	**1434**

Interestingly, Dhunche has only moderate and steep slope, whereas Palungtar, Thaha, Bidur Municipalities buildings located in relatively flat lands. This also shows the potential of landslide hazards in such locations.

4.7.9 Percentage of Irregularity for Structure type 6 and 7

The relationship with building irregularity for particularly structure type 6 and 7 (which are RC Frame Engineered and RC Frame Non-Engineered buildings) have shown in the following table. About 4% of buildings have either overhang or soft storey character. Remaining buildings are in regular shapes.

Table 4-38: Buildings with Irregularities for RC engineered and RC non-engineered by Municipalities in outside KV.

Municipality	Overhang & Soft Story	Regular	Total
Bidur			
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	5.41%	94.59%	100.0%
Dhunche			
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	10.42%	89.58%	100.0%
Gerkhu			
RCFrame_non_enginnered	**0.00%**	**100.00%**	100.0%
Gorkha			
RCFrame_enginnered	0.00%	100.00%	100.0%
RCFrame_non_enginnered	8.16%	91.84%	100.0%
Lahare pauwa			
RCFrame_non_enginnered	22.22%	77.78%	100.0%
Nilakantha			
RCFrame_enginnered	6.67%	93.33%	100.0%
RCFrame_non_enginnered	0.00%	100.00%	100.0%
Palungtar			
RCFrame_non_enginnered	4.76%	95.24%	100.0%
Panchkal			
RCFrame_enginnered	**0.0%**	100.0%	100.0%
RCFrame_non_enginnered	**0.0%**	100.0%	100.0%
Thaha			
RCFrame_non_enginnered	**0.00%**	**100.00%**	**100.0%**
Grand Total	4.71%	**95.29%**	100.0%

4.7.10 Percentage of Roof type for Structure type 4 and 5

The relationship with building roof type for particularly structure type 6 and 7 (which are RC Frame Engineered and RC Frame Non-Engineered buildings) have shown in the following Table 4-39.

Table 4-39: Buildings with roof type for RC engineered and RC non-engineered by Municipalities in outside KV

Municipality	Flexible (Wooden & CGI Sheet)	Flexible (Wooden & Clay)	Rigid Concrete	Total
Bidur	**60.38%**	**5.66%**	**33.96%**	**100.00%**
Brick_with_cement_mortar	35.00%	0.00%	65.00%	100.00%
Brick_with_Mud_mortar	75.76%	9.09%	15.15%	100.00%
Dhunche	**60.00%**	**0.00%**	**40.00%**	**100.00%**
Brick_with_cement_mortar	61.11%	0.00%	38.89%	100.00%
Brick_with_Mud_mortar	50.00%	0.00%	50.00%	100.00%
Gerkhu	**50.00%**	**0.00%**	**50.00%**	**100.00%**
Brick_with_cement_mortar	50.00%	0.00%	50.00%	100.00%
Gorkha	**57.14%**	**0.00%**	**42.86%**	**100.00%**
Brick_with_cement_mortar	33.33%	0.00%	66.67%	100.00%
Brick_with_Mud_mortar	88.89%	0.00%	11.11%	100.00%
Lahare pauwa	**25.00%**	**12.50%**	**62.50%**	**100.00%**
Brick_with_cement_mortar	28.57%	0.00%	71.43%	100.00%
Brick_with_Mud_mortar	0.00%	100.00%	0.00%	100.00%
Nilakantha	**73.91%**	**0.00%**	**26.09%**	**100.00%**
Brick_with_cement_mortar	73.91%	0.00%	26.09%	100.00%
Palungtar	**80.77%**	**19.23%**	**0.00%**	**100.00%**
Brick_with_cement_mortar	92.59%	7.41%	0.00%	100.00%
Brick_with_Mud_mortar	74.51%	25.49%	0.00%	100.00%
Panchkal	**80.49%**	**7.80%**	**11.71%**	**100.00%**
Brick_with_cement_mortar	71.43%	3.57%	25.00%	100.00%
Brick_with_Mud_mortar	83.89%	9.40%	6.71%	100.00%
Thaha	**53.66%**	**0.00%**	**46.34%**	**100.00%**
Brick_with_cement_mortar	56.41%	0.00%	43.59%	100.00%
Brick_with_Mud_mortar	0.00%	0.00%	100.00%	100.00%
Grand Total	**71.34%**	**7.32%**	**21.34%**	**100.00%**

4.7.11 DAMAGE TO BUILDINGS

Table 4-40: Damage grade outside KV Municipalities

	Damage Grade					
Municipality	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**	**Total**
Bidur	67	52	20	3	7	149
Dhunche	55	52	36	32	34	209
Gerkhu	20	11	7	4	15	57
Gorkha	80	25	27	28	23	183
Lahare pauwa	1	23	15	22		61
Nilakantha	136	15	8	12	4	175
Palungtar	73	50	21	21	8	173
Panchkal	106	62	59	76	14	317
Thaha	38	33	22	14	3	110
Total	576	**323**	**215**	**212**	**108**	**1434**

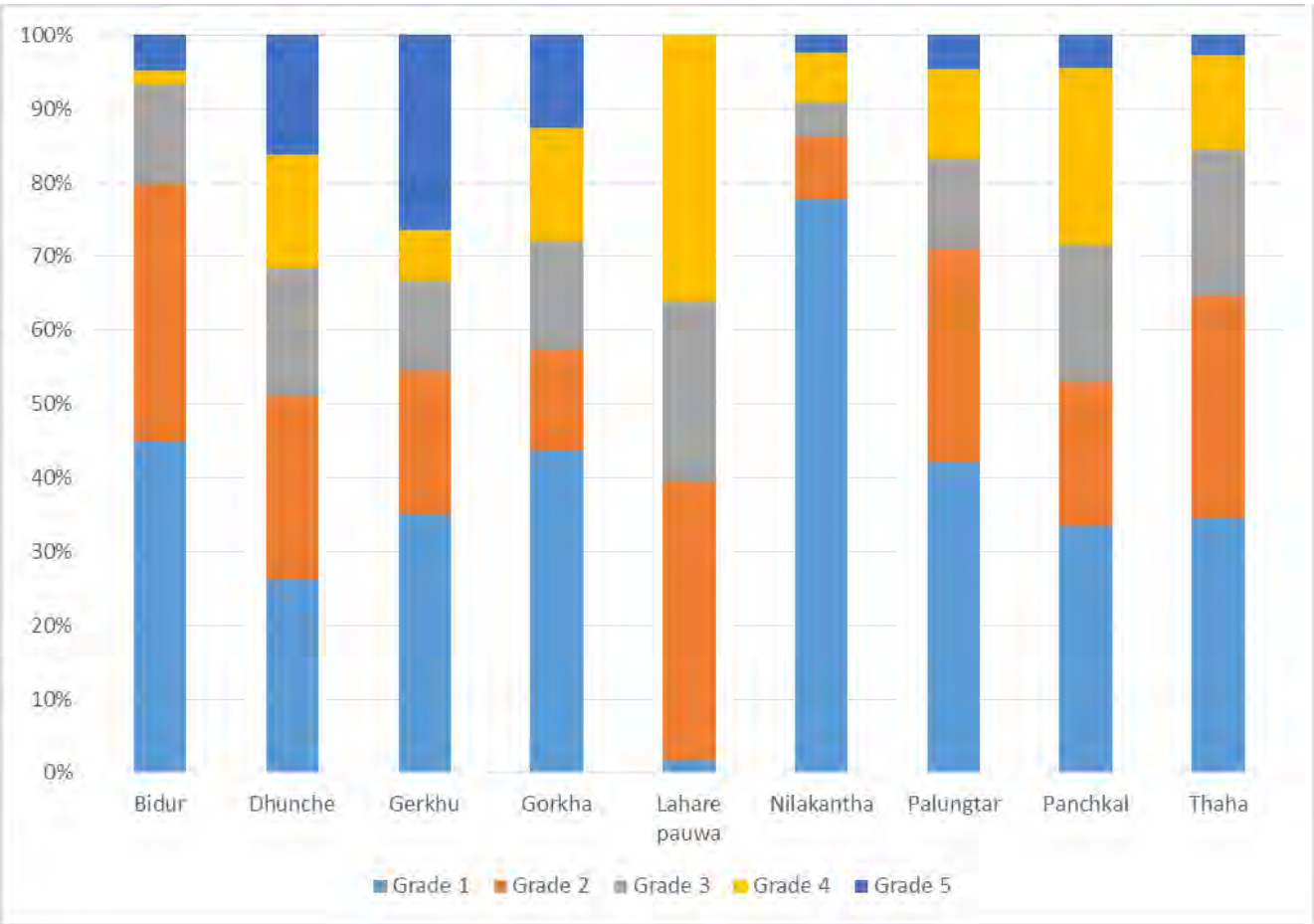


Fig. 4-22: Damage grade outside KV Municipalities

4.8 Damage Degree and Structural Type

Damage to buildings by structural types for outside KV Municipalities in shown in following table with damage grade. The detail of damage grade percentage is also shown in the Table 4-42.

Table 4-41: Damage Degree and Structural Type for Municipalities outside KV.

Municipality	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total
Bidur	**67**	**52**	**20**	**3**	**7**	**149**
Adobe	0	2	1	0	0	3
Stone with Mud Mortar	5	4	4	1	2	16
Stone with Cement Mortar	0	1	0	0	0	1
Brick with Mud Mortar	6	11	11	2	3	33
Brick with Cement Mortar	7	11	1	0	1	20
RCFrame NonEng	47	23	3	0	1	74
RCFrame Eng	2	**0**	0	0	0	2
Dhunche	**55**	**52**	**36**	**32**	**34**	**209**
Adobe	0	1	0	0	1	2
Stone with Mud Mortar	1	11	26	27	26	91
Stone with Cement Mortar	18	13	8	3	4	46
Brick with Mud Mortar	0	1	0	0	1	2
Brick with Cement Mortar	8	7	2	0	1	18
RCFrame NonEng	27	18	0	2	1	48
RCFrame Eng	1	1	0	0	0	2

Gerkhu	**20**	**11**	**7**	**4**	**15**	**57**
Adobe	0	**0**	1	0	0	1
Stone with Mud Mortar	5	7	3	2	15	32
Stone with Cement Mortar	6		3	1	0	10
Brick with Cement Mortar	3	4	0	1	0	8
RCFrame NonEng	6	0	0	0	0	6
Gorkha	**80**	**25**	**27**	**28**	**23**	**183**
Stone with Mud Mortar	6	11	18	24	23	82
Stone with Cement Mortar	2	2	0	0	0	4
Brick with Mud Mortar	3	2	9	4	0	18
Brick with Cement Mortar	15	9	0	0	0	24
RCFrame NonEng	48	1	0	0	0	49
RCFrame Eng	6	**0**	0	0	0	6
Lahare pauwa	**1**	**23**	**15**	**22**	**0**	**61**
Stone with Mud Mortar	0	**0**	11	17	**0**	28
Stone with Cement Mortar	0	2	1	4	**0**	7
Brick with Mud Mortar	0	**0**	1	**0**	**0**	1
RCFrame NonEng	0	6	**0**	1	**0**	7
Nilakantha	**136**	**15**	**8**	**12**	**4**	**175**
Stone with Mud Mortar	3	10	7	12	4	36
Stone with Cement Mortar	7	2	0	0	0	9
Brick with Cement Mortar	20	2	1	0	0	23
RCFrame NonEng	91	1	0	0	0	92
RCFrame Eng	15	**0**	0	0	0	15
Palungtar	**73**	**50**	**21**	**21**	**8**	**173**
Adobe	0	**0**	3	3	0	6
Stone with Mud Mortar	13	19	11	9	6	58
Stone with Cement Mortar	0	2	0	0	1	3
Brick with Mud Mortar	9	25	7	9	1	51
Brick with Cement Mortar	25	2	0	0	0	27
RCFrame NonEng	20	1	0	0	0	21
Other	6	1	0	0	0	7
Panchkal	**106**	**62**	**59**	**76**	**14**	**317**
Adobe	0	6	6	8	0	20
Stone with Mud Mortar	2	2	10	14	4	32
Stone with Cement Mortar	2	**0**	0	4	0	6
Brick with Mud Mortar	6	46	41	46	10	149
Brick with Cement Mortar	46	6	2	2	0	56
RCFrame NonEng	44	2	0	2	0	48
RCFrame Eng	4	**0**	0	0	0	4
Other	2	**0**	0	0	0	2
Thaha	**38**	**33**	**22**	**14**	**3**	**110**
Adobe	0	**0**	2	0	0	2
Stone with Mud Mortar	6	5	17	14	3	45
Stone with Cement Mortar	0	1	1	0	0	2
Brick with Mud Mortar	0	**0**	2	0	0	2
Brick with Cement Mortar	17	22	0	0	0	39

RCFrame NonEng	13	5	0	0	0	18
Other	2	0	0	0	0	2
Grand Total	**576**	**323**	**215**	**212**	**108**	**1434**

ACTIVITY 4: INTENSITY SURVEY

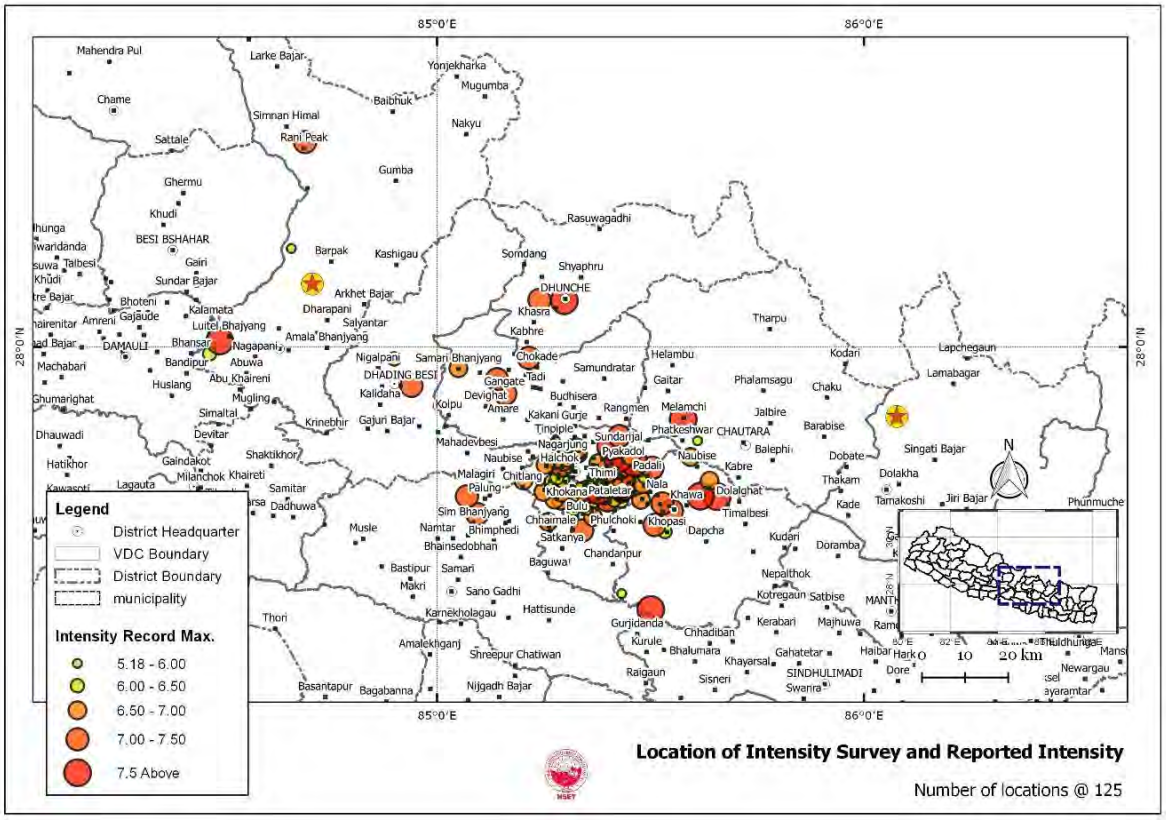
4.9 INTENSITY SURVEY BY REGION (MUNICIPALITY)

The scope of work for Activity 4 was specified as the questionnaire survey of intensity felt by responders after 25 April 2015 Nepal Gorkha Earthquake. This survey was carried out in sample basis which in selected areas/regions conducted together with rest of activities (Activity 1, Activity 2, and Activity 3) in project implementation area. The total number of surveyed questionnaire were in 126 settlement/ locations.

The objective of this survey was to prepare more extensive survey of seismic intensities in the KV, and relatively heavily damaged areas (regions) of 2015 Gorkha Earthquake in the country. These municipalities were chosen relatively higher loss (intensity areas/ municipalities) as felt.

The methodology for the survey was seismic intensity questionnaire method. The questionnaire is shown in Annex V, and further detail of the methodology is explained in Murakami et al. 2015.[1] The survey questionnaire was originally developed in English and later translated into Nepali for local purpose.

The location of intensity survey is shown in Map 4-4 as well as the results of intensity distribution across the survey area. The results of intensity survey was calculated according to the calculation sheet developed by Murakami et al (2015).

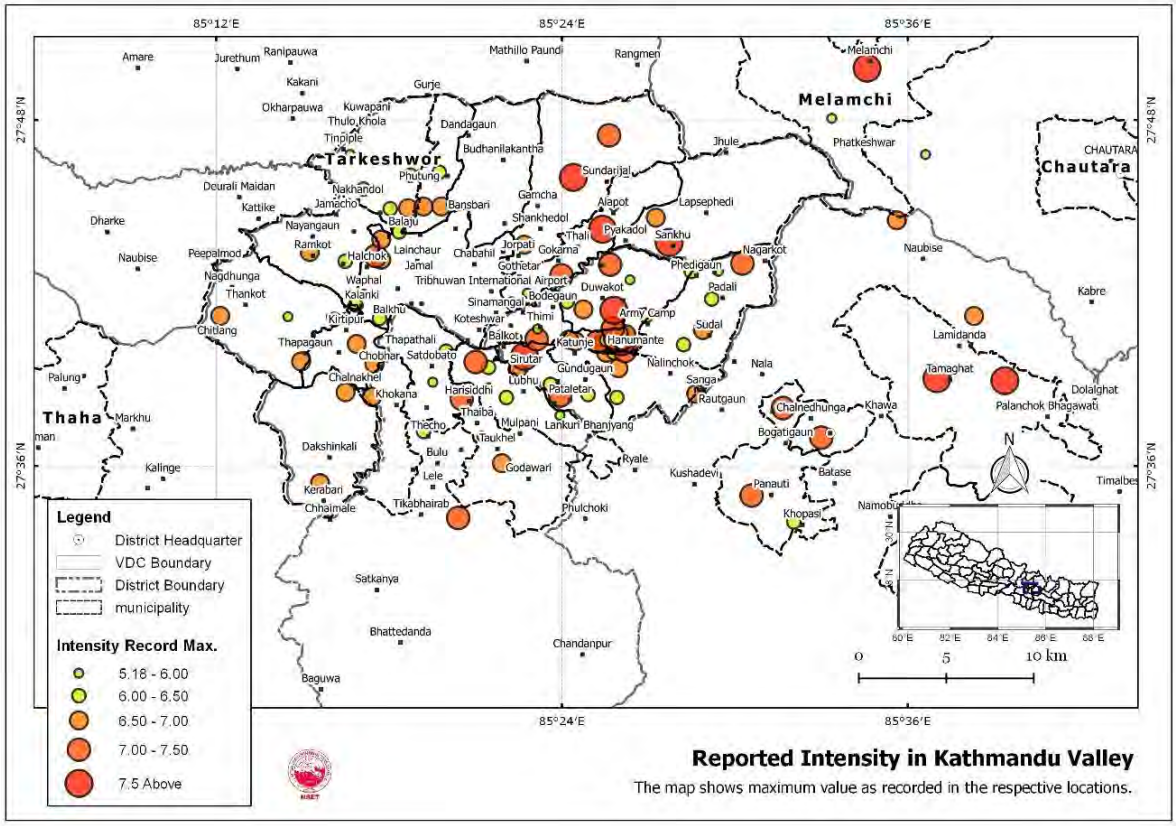


Map 4-4: Locations of Seismic Intensity Survey and Intensity Values as calculated in highly affected districts of 2015 Nepal Gorkha Earthquake.

[1] Seismic intensity questionnaire survey for the 2015 Gorkha, Nepal earthquake: preliminary results and damage observations by H.Murakami,R.Guragain, B.Pradhan, S.Adhikari, G.Basyal, and S.Mori

The version of questionnaire was used ver. 6.0 which contains 27 questions and intensity related question items including others (see Annex V for detail of questionnaire in English and Nepali). The questionnaire intensity is calculated by taking average of intensity coefficients, while intensity coefficients related to the building one was located are to be multiplied by building coefficients.

The intensity distribution for Kathmandu Valley is shown in the following Map 4-5.



Map 4-5: Locations of Seismic Intensity Survey in Kathmandu Valley and Intensity Values in Kathmandu Valley and its surrounding districts.

The survey was limited in the sites where surveyors were reached for the building inventory, and damage assessment surveys. The result is completely depend on the responder's response/reply. This section of report presents summary of the data carried out (Table 4-42) under this activity, distribution of sample surveys are shown in the (Map 4-5), detail of survey location (Annex VI), and summary of assessment.

Table 4-42: Activity 2 Average intensity from Questionnaire Survey.

Municipality	Location	Intensity		Municipality	Location	Intensity
Anantalinges hore	Balkot	6.3		Bajrabarahi	Chapagaun	6.2
	Charkhandi	5.7			Lele	6.8
	Dadhikot	6.2			Thecho	5.8
	Dokathali	5.5			Tikabhairab	6.2
Chandragiri	Badbhanjang	6		Changunarayan	Changunarayan	6.3
	Bauthali chowk	5.8			Kapahiti	5.8
	Gurjudhara	5.5			NEC AREA	5.9
	Machhegaun	5.1			Pikhel	5.7
	Matatirtha	6			Sarasawatikhel	5.8

Municipality	Location	Intensity		Municipality	Location	Intensity
	Naikap	6		Dakchinkali	Chalnakhel	6.2
	Thankot	6			Pharping	6
Godawari	Badegaun	6.2		Suryabinayak	Bairikhel	6.3
	Bisankhu	6.1			Katunje	6.2
	Godawari	6.1			Sipadol	6.1
	Taukhel	6			Srijananagar	5.9
Kageshorema nahara	Aalapot	5.5		Mahalaxmi	Gwarko	5.6
	Bhadrabas	6.5			Imadol	5.8
	Gagalphedi	5.7			Lamatar	5.7
	Gothatar	5.8			Lubhu	5.8
	Kadaghari	5.6			Tikathali	5.9
Kritipur	Chilanchobal	5.7		Gokarneshwor	Deshe Gokarna	6.1
	Chovar	5.9			Gokarneswor	5.9
	Panga	5.9			Jorpati	5.9
	Taudaha	5.9			Mulpani	6.1
	Taukhel	5.8			Sundarijal	6
Tokha	Banayatar	6		Manjushree Nagarkot	Chaap	5.7
	Jhor	6			Chhayabasti	5.4
	Siddhitol	6.1			Nagarkot	6.6
	Tokha Chandeswori	6.1			Sudal	6.3
	Tokha Saraswati	6			Telkot	5.7
Nagarjune	Bafal	6		Shankarapur	Bhulbhu	6.1
	Kalanki	6.2			Indrayani	5.8
	Ramkot	6.1			Jarsingpauwa	6
	Soltidobato	6.1			Sankhu	5.7
Tarkeshwore	Futung	6.2		Madyapur Thimi	Bahakha bazaar	5.8
	Ghatkekhola	6.1			Bode	5.8
	Jaranku	6			Gattaghar	5.7
	Kavresthali	6			Tachu	5.8
	Nepaltar	6.1				

Table 4-433: Activity 3 Average intensity from Questionnaire Survey

Municipality	Location	Intensity		Municipality	Location	Intensity
Bidur	Battar	6.2		Thaha	Angaare	6.1
	Bidur	6.6			Daman	6.5
	Dhunge	6.3			Palung	6.8
Dunche	Dhunche	6.3		Gerkhu	Betrawati	6.8
Gorkha	Gorkha	6.3		Nilkantha	Nilakantha	6.6
Palungtar	Palungtar	6.4		Panchkhal	Rampur	6.4
					Tamagaht	6.4

As for the macro distribution of seismic intensities with the results from the present survey is shown in Map 4-5. According to the Intensity distribution, intensity in Kathmandu is about VII (very strong). Where northern districts (locations) record higher intensity (VII and IX).

The average questionnaire intensities reflect damage levels of buildings and houses in each location. According to the survey, preliminary results of the seismic intensity calculated by the questionnaire survey shows that the tendency of smaller than MM Intensity reported by USGS.

5 CONLUSIONS

There was huge need for conducting such detail damage assessment of buildings after April 25, 2015 Gorkha Earthquake in Nepal. This type of survey has been expected to give much clearer scenario of post-earthquake damage, especially the shaking intensities vs the type of damages in different structural types of buildings in KV and outside KV. The survey was conducted building inventory, damage assessment in 2 Municipalities of KV as 100% survey, where as sample survey in 16 municipalities in KV was conducted together with outside KV Municipalities. In addition to this, intensity survey in the locations together with building damage survey was also carried out. Trained engineers were mobilized as paid volunteers through particular selection process to conduct the Damage Assessment of the buildings. Extensive explanation and discussions were held in the training to clarify the information to be collected and how to act in the field.

The first step of assessment was started in Bhaktapur Municipality and then in Kahtmandu Valley municipalities in second step. In third step, volunteers were mobilised to outside KV. All the buildings were visited except where the owner of building were denied to give permission, some of the government office buildings, some hospitals and schools. Supervisors carried out proper planning for the groups and continuously surveyed the groups to ensure the quality control and effectiveness. GIS mappers were also mobilized in the field for preparation of field paper and plotting the surveyed building location in GIS.

We found many buildings were either removed, modified, some repaired for shelter, so that the photographs may have not represent actual damage immediate earthquake the building.

ANNEXES

Annex I: Team Members for the Building Inventory, Damage and Seismic Intensity Survey

SN	Name	Designation
1	Manager: Dr. Kenpei Kojika Team Leader: Mr. Akira Inoue	JICA Project Team (JPT)
2	Coordinator: Dr. Ramesh Guragain Manager: Gopi Krishna Basyal GIS Expert: Sujan Raj Adhikari Civil Engineer: Suman Pradhan	NSET
3	Coordinator: Suresh Shrestha Team Leader: Gautam Shakya (GIS Manager) Group Leader: Bishwambhar Lal Shrestha (Civil Engineer) Group Leader: Bijaya Joshi (Civil Engineer) Group Leader: Gyanendra Maharjan (Urban Planner) Administrator: Bimal Shrestha	GeoSpatial Systems Pvt. Ltd.

Project Implementation Group at NSET

SN	Name	Designation
1	Project Director: Dr. Ramesh Guragain	Deputy Executive Director
2 3 4	Project Manager: Gopi Krishna Basyal GIS Expert: Sujan Raj Adhikari Civil Engineer: Suman Pradhan	Geographer Geologist Structural Engineer
5 6 7 8	Administration Support: Administration Division Finance: Finance Division GIS Support : Udisha Denekhu Civil Engineers: Kapil Regmi Deepak Saud Pradip Thapa Ayush Baskota Kishore Timsina Srijana Gurung Shrestha Rabin Subedi Aakriti Singh Shrestha Deena Shrestha	

Annex II: Building Inventory Survey Form

Refer to the ToR.

Building Inventory and damage survey Sheet Date:

Municipality		Ward	Tole
Building Address *1			
Building ID			
Longitude		Latitude	
No of Storey		Approx. building area	M * M
Structure Type *2	1 Adobe	2 Stone with Mud Mortar	3 Stone with Cement Mortar
	4 Brick with mud mortar	5 Brick with cement mortar	6 RC Frame Non Engineered
	7 RC Frame Engineered	Other (steel, wooden Frame)	
Irregularity *3	1 Soft storey	2 overhang	3 ordinary
Roof Type	1 Flexible (wooden and clay)	2 Flexible (wooden and cgis)	3 Rigid (concrete)
Usage	1 Residential	2 Residential and shop at Ground floor level	3 office
	4 Commercial	5 Educational	6 Hospital
	7 Governmental Building	8 Historical and Temple	9 Hotel and restaurant
	10 Industrial	11 Assembly	12 others
Construction year *7	1. 1- 10 years	2. 10-20 years	3. 20-30 years | 4 > 30 years
Damage Degree *4	0 No damage	1 Slight	2 Moderate
	3 Substantial to heavy	4 Very Heavy	5 Destruction
Ground Failure	O Not found	1 Liquefaction	2 Landslide
	3 Settlement		
Adjacent Building	1 free standing	2 Building 1 side	3 building 2 or more side
Landslope*5	1 Flat land	2 Moderate	3 Steep
Photo*6	Link to building ID		
Remarks	*1 Address not mandatory *2 Structural type at GFl is shown in case of mixed structure vertically *3 Irregularity, soft storey means RCC Frame with no or little brick wall at GFl compared with upper storey *4 Damage degree refer to attached EMS-98 *5 Land slope is judge by visual observation *6 at least 2 including overview and specific feature *7 Constructed yearly by visual observation at GFL		

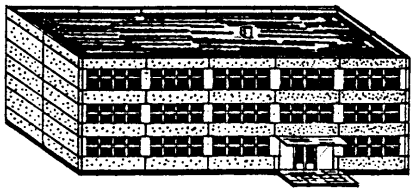
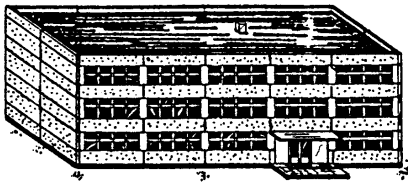
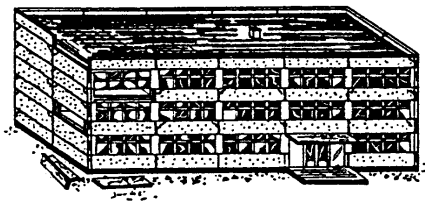
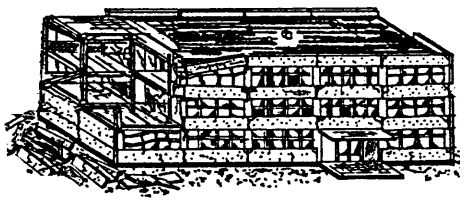
Annex III : Damage Grade of the Buildings for Masonry and RCC Buildings.

Classification from European Macro-seismic Scale (EMS 98)

For Masonry Buildings

Classification of damage to masonry buildings	
 **Grade 1: Negligible to slight damage**	**Structural damage : No** **Non-structural damage: Slight** • Hair-line cracks in very few walls. • Fall of small pieces of plaster only. • Fall of loose stones from upper parts of buildings in very few cases.
 **Grade 2: Moderate damage**	**Structural damage : Slight** **Non-structural damage: Moderate** • Cracks in many walls. • Fall of fairly large pieces of plaster. • Partial collapse of chimneys.
 **Grade 3: Substantial to heavy damage**	**Structural damage: Moderate** **Non-structural damage: Heavy** • Large and extensive cracks in most walls. • Roof tiles detach. • Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
 **Grade 4: Very heavy damage**	**Structural damage: Heavy** **Non-structural damage: Very heavy** Serious failure of walls; partial structural failure of roofs and floors.
 **Grade 5: Destruction**	**Structural damage: very heavy** • Total or near total collapse.

Damage Grade of the Buildings for Reinforced Concrete Buildings.
Classification from European Macro-seismic Scale (EMS 98)
For Reinforced Concrete Buildings

Classification of damage to buildings of reinforced concrete	
 **Grade 1: Negligible to slight damage**	**Structural damage : No** **Non-structural damage: Slight** • Fine cracks in plaster over frame members or in walls at the base. • Fine cracks in partitions and infills.
 **Grade 2: Moderate damage**	**Structural damage : Slight** **Non-structural damage: Moderate** • Cracks in columns and beams of frames and in structural walls. • Cracks in partition and infill walls; fall of brittle cladding and plaster. • Falling of mortar from the joints of wall panels.
 **Grade 3: Substantial to heavy damage**	**Structural damage: Moderate** **Non-structural damage: Heavy** • Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. • Spalling of concrete cover, buckling of reinforced bars. • Large cracks in partition and infill walls, failure of individual infill panels.
 **Grade 4: Very heavy damage**	**Structural damage: Heavy** **Non-structural damage: Very heavy** • Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns. • Collapse of a few columns or of a single upper floor.
 **Grade 5: Destruction**	**Structural damage: very heavy** • Collapse of ground floor or parts (e.g. wings) of buildings.

Annex IV : Training Concept Note on Building Inventory and Damage Assessment of Buildings

Background

On 25 April 2015 at 11:56 local time, a 7.8 magnitude (M7.8) earthquake struck Nepal, with epicenter in Gorkha District (77km NW of Kathmandu). The Government reports that 14 districts of western and central regions are severely affected.

With project requirement and needs to mobilise surveyors for building inventory and damage assessment, the training program was organized in series. The training was carries out based on the document on post disaster damage assessment guidelines published by Department of Urban Development & Building Construction, Government of Nepal (DUDBC/GoN).

Objective of training

The main objective of this training is to enhance the knowledge and skills of Surveyors to carry out building inventory, damage assessment of buildings as required for the proposed survey.

Target group for the training

The intended target group of this course are civil engineers and architects.

Selection of participants

NSET has been continuously calling for volunteers (paid volunteers) for the similar surveys. The applicants are short-listed from NSET or other organization volunteer call list on the following basis;

- have completed civil engineer or architect,
- ready to work in field, travelling as required,
- can provide one month on field work at least.

The short-listed applicants are called two days before the training to brief about training and assessment objective, methodology, time schedule, assessment area and logistic system. The interested applicants are called to sign up on training. Then sign up applicants are selected for further assignments.

Approach and methodology

The training course focuses on interactive lectures as well as exercises and demonstration. Trainees are open to share their practical experiences with each other and also with the trainer. The training delivery has been designed using several methods including form of power point presentation through multimedia projection system, field visit and others. Major part of this training will follow and use of Nepalese guidelines on post-earthquake damage assessment DUDBC/NSET/UNDP.

Duration of training

The training course is design for two day interactive lectures followed by one day guided survey on field.

Structure of the training course

The entire training has been divided into 3 modules based upon the main theme and each module was sub-divided into sessions.

Module 1: Detail damage assessment (includes a) Damage pattern of buildings; b) Identification of damage level; and c) Detail evaluation process

Module 2: Social consideration

Module 3: Exercise on detail evaluation assessment – includes a) Case study; b) Exercise; and c) Guided Survey

Module 4 : Survey and Mapping

Human Resources

The training lecture were to carry out by three instructor. They are structural engineer/civil engineer and GIS Experts. During training surveyor supervisor and logistic person has to assist the instructors.

Other Arrangements for the Survey and Tasks

Approach

- Work with local authority:- municipalities, District Technical Office (if require)
- Mobilization of volunteer engineers
- Training to volunteers, GIS Mappers
- Follow/ use of Nepalese guidelines on post-earthquake damage assessment DUDBC/NSET/UNDP

Main activities

- Conduct detail building damage assessment on as designed in ToR (Selection of municipalities, and develop Survey Design in Close coordination with JICA Team).
- Building survey as per ToR (for 50,000 Buildings in Lalitpur and Bhaktapur Municipality) and other municipalities inside and outside Kathmandu Valley for sample.
- The building information will be collect by using App by smart phone and mapped on GIS.
- Necessary processing of spatial and non-spatial data collected from field.

Annex V: Seismic Intensity Survey Form in Nepali and English

भूकम्पीय तिब्रता सम्बन्धी प्रश्नावली सर्भेक्षण
गोरखा, नेपाल भूकम्प अप्रिल २५, २०१५

भूकम्प प्रविधि राष्ट्रिय समाज नेपालको सहकार्यमा वैसाख १२ मा गएको बिनासकारी भूकम्पको तिब्रताको अध्यन तथा अभिलेखीकरणकालागि यो सर्वेक्षण फारम तयार पारिएको हो । यो सर्वेक्षणबाट सम्बन्धित जिल्लाहरुका बिभिन्न स्थानहरुमा भूकम्पको तिब्रताको अवस्थाको जानकारी प्राप्तहुने र अन्तिममा तिब्रताको नक्सान्कन तयार परिने छ । यो सर्वेक्षणमा सहभागी हुने महानुभावहरुको योगदानलाइ पूर्ण कदर गर्दै वहाँहरुको नाम गोप्य राखिने छ । यसमा व्यक्त भएका अभिव्यक्तहरु व्यक्तिगत पहिचान हुनेगरी कतै पनि प्रयोग गरिने छैन ।
नाम: ''''''''''''''''''''''''''''''''''''।।।

१. भूकम्प गइरहेको बेला तपाईं कहाँ हुनुहुन्थ्यो ?
१) ठेगाना
२) शहर/गाउँ
३) जिल्ला

२. तपाईंले भूकम्प आएको कसरी थाहा पाउनुभयो ?
१) मैले भूकम्प आएको हो वा के भएको हो ठम्याउनै सकिन
२) मैले पहिलो पटक नै भूकम्प हो भन्ने थाहा पाइहालें
३) मलाई सम्हालिएर उभिन एकदमै गाह्रो भइरहेको थियो
४) म उभिन नै सकिन
५) म लडें

३. जमिन हल्लिदा तपाईंले कस्तो अनुभव गर्नुभयो ?
१) बिस्तारै हल्लिएको जस्तो लाग्यो
२) हल्का ट्रक मेरै अगाडिबाट गएजस्तो लाग्यो
३) गह्रौ सामानले भरिभराउ ट्रक मेरै अगाडिबाट गएजस्तो लाग्यो
४) केही गह्रौं सामान घरभित्र नै खसेको जस्तो लाग्यो
५) भवनभित्र केही पड्किएजस्तो लाग्यो

४. भूकम्प गइरहेको बेला तपाईं घरबाहिर हुनुहुन्थ्यो कि घरभित्र ?
१) घरभित्र
२) घरबाहिर
३) सवारी साधन भित्र

५. भवनको मुख्य सामाग्री के थियो ?
१) ढुंगा
२) कच्ची ईंटा
३) सिमेन्ट र ईंटा
४) काठ र ईंटा
५) काटिएको ढुंगा
६) पीलर सिमेन्ट क्रंकिट
७) अन्य

६. तपाईं रहेको भवन कति पुरानो थियो ? ( ) वर्ष

७. भवन कतितले थियो ? ( ) तला

८. तपाईं कुन तलामा रहेको बेला भूकम्प आइरहेको थाहा पाउनुभयो ?
१) भुँईतला
२) पहिलो तल्ला
३) दोस्रो तला
४) तेस्रो तल्ला
( ) अन्य तल्ला भए उल्लेख गर्नुहोस्

९. के तपाईं डराउनुभयो ?
१) अहँ, म डराइन
२) केही मात्रामा डराँए, तर म भवनभित्रै भएर पनि सुरक्षित महशुस गरिरहेको थिएँ
३) एकदमै धेरै डराएँ तर म भवनभित्रै रहेर पनि सुरक्षित महशुस गरिरहेको थिएँ
४) लगभग पुरै डराएँ
५) एकदमै डराएँ र के गर्ने भन्ने मेसो नै पाइन
६) अत्तालिए

१०. तपाईंको कोठामा झुन्ड्याइएको सामानहरु जस्तै- तस्विर अनि बत्तीको अवस्था के भयो ?
१) केही भएन
२) बिना आवाज केही मात्रामा हल्लियो
३) एकदमै ठुलो आवाजका साथ ती सामान हल्लिए र केही सामान हल्लिदैँ यत्रतत्र भए
४) केही सामान भुईंमा झरेर क्षतिग्रस्त बने
५) प्राय झुन्ड्याइएका सामान झरेर क्षतिग्रस्त बने
६) सबै नै सामानहरु भुईंमा झरेर क्षतिग्रस्त बने

११. च्याकमा राखिएका सामानहरुको अवस्था कस्तो रह्यो ?
१) केही भएन
२) केही सामानहरु च्याकमै यताउता भए
३) केही सामानहरु च्याकबाट भुईंमा खसे
४) प्राय सामानहरु च्याकबाट भुईंमा खसे
५) च्याक नै ढल्यो

१२. फर्निचरका सामानहरुको अवस्था कस्तो रह्यो ?
१) केही भएन
२) केही मात्रामा हल्लियो
३) एकदमै हल्लियो
४) गह्रो फर्निचरहरु केही मात्रामा यताउता सर्‍यो
५) धेरैजसो गह्रौ फर्निचरहरु सर्नुका साथै केही फर्निचर पल्टिए
६) धेरैजसो फर्निचर पल्टिए र धेरै फर्निचर क्षतिग्रस्त बने

१३. भूकम्प आइरहेका बेला तपाईंले कस्तो किसिमको आवाज सुन्नुभयो ?
१) आवाज नै सुनिन
२) झ्याल, ढोका, भाँडाकुडाँको खडखड आवाज तथा भित्ता र कोठाको चरचर आवाज सुनें
३) भवनका सबै भागमा रहेका झ्याल, ढोकाको चरचर र खडखड आवाज सुनें
४) पुरै भवनको खडखड, चरचर र तर्साउने किसिमको आवाज सुनें

१४. तपाईं बसेको भवनको प्लाष्टरको अवस्था कस्तो रह्यो ?
१) केही भएन
२) केही सानो चर्काइ देखियो साथै केही मात्रामा प्लाष्टर उप्कियो
३) प्लाष्टरको ठुलो भागहरु उप्किएर उत्रतत्र छरियो
४) प्लाष्टरको ठुलो भागहरु जतातै सबैतिर छरियो
५) सबै प्लाष्टर उप्किएर जतातै सबैतिर छरियो

१५. घरको बाहिरी पर्खालको अवस्था कस्तो रह्यो ?
१) केही भएन
२) सानो सानो चर्काइ देखियो
३) ठुलो र गहिरो चर्काइ देखियो
४) ग्याप नै देखिने गरी चर्काइ देखियो
५) एकापट्टीको पर्खालको भाग खस्यो
६) दुई तिरकै पर्खालको भाग खस्यो

१६. पानीट्याङ्कीको अवस्था के रह्यो ?
१) केही क्षति भएन
२) केही मात्रामा क्षति पुग्यो
३) धेरैमात्रामा क्षति भयो
४) पुरै ध्वस्त भयो

१७. चिम्नीको अवस्था के रह्यो ?
१) केही भएन
२) चिम्नीको केही भाग चर्क्यो
३) केही भाग खस्यो
४) चिम्नी भत्केर खस्यो

१८. तपाईंको गाउँ वा छिमेकमा रहेको सडकमा लगाइएको इँटको पर्खालमा कस्तो असर पर्‍यो ?
१) केही क्षति भएन
२) केही सानो चर्काइ देखियो
३) केही भागमा ठुलै चर्काइ देखियो
४) केही भाग क्षति भएर खस्यो
५) प्रायः पर्खाल खस्यो

१९. तपाईंको गाउँ वा छिमेकमा भएको कच्ची इँटाको घरको अवस्था कस्तो रह्यो ?

१) केही भएन
२) पर्खालमा केही चर्काइ देखियो
३) घरको बाहिरी पर्खाल र छानोमा क्षति पुग्यो तर भित्री भागमा खासै केही क्षति भएन
४) घरको बाहिरी पर्खाल पुरै भत्क्यो तर भित्री भागमा खासै असर पुगेन
५) आंशिक मात्रामा क्षति पुग्यो
६) पूर्णरुपमा क्षतिग्रस्त बन्यो

२०. तपाईंको गाउँ वा छिमेकमा भएको इँटाले बनाएको घरको अवस्था कस्तो रह्यो ?
१) केही भएन
२) पर्खालमा साना साना चर्काइ देखियो
३) घरको बाहिरी पर्खाल र छानोमा क्षति पुग्यो तर भित्री भागमा खासै केही क्षति भएन
४) घरको बाहिरी पर्खाल पुरै भत्क्यो तर भित्री भागमा खासै असर पुगेन
५) आंशिक मात्रामा क्षति पुग्यो
६) पूर्णरुपमा क्षतिग्रस्त बन्यो

२१. तपाईंको गाउँ वा छिमेकमा पीलर सिमेन्ट क्रंकिट का पक्की भवनहरुको अवस्था कस्तो रह्यो ?
१) केही भएन
२) पर्खालमा साना साना चर्काइ देखियो
३) विम र पिलरमा सानो चर्काइ देखियो
४) घरको बाहिरी पर्खाल र छानोमा क्षति पुग्यो तर भित्री भागमा खासै केही क्षति भएन
५) आंशिक मात्रामा क्षति पुग्यो
६) पूर्णरुपमा क्षतिग्रस्त बन्यो

२२. सडकको अवस्था कस्तो रह्यो ?
१) केही भएन
२) आंशिक मात्रामा क्षति भयो तर सवारी साधनहरु सामान्य गतिमा गुडिरहे
३) अलि बढी नै क्षति भयो र सवारी साधनहरु गुड्रेपनि बिस्तारै गुडे
४) धेरै नै क्षतिग्रस्त बन्यो र सवारी साधनहरु सधैं नै बिस्तारै गुडे
५) सवारी साधनहरु गुड्नै नसक्ने गरी क्षतिग्रस्त बने तर साइकल चाँही गए
६) पैदलयात्रीहरु मात्र हिँड्न मिल्ने गरी सडक क्षतिग्रस्त बन्यो

२३. जमिनको अवस्था कस्तो रह्यो ?
१) केही भएन
२) मसिनो चर्काइ देखियो
३) औंला छिर्ने गरी चर्काइ देखियो
४) खुट्टा छिर्ने गरी चर्काइ देखियो
५) पुरै शरिर नै छिर्न सक्ने गरी चर्काइ देखियो
६) ठुलो चर्काइका साथ तेस्रो तथा ठाडो चिराहरु नै देखियो
७) धेरै तेर्सा तथा ठाडा चर्काइहरु देखियो

२४. तपाईं वा तपाईंको परिवारको सदस्य कोही भवनभित्र फस्नुभयो ?
१) फसेनन्
२) फसे, परिवारले त्यहाँबाट बाहिर निकाले
३) फसे, छिमेकी र आफन्तले उद्धार गरेर बाहिर निकाले
४) फसे, उद्धारकर्मी, प्रहरी, सेना आदि मिलेर बाहिर निकाले
५) फसे, तर उद्धार गर्न सकिएन

२५. भूकम्पमा परी तपाईं वा तपाईंको परिवारको कोही घाइते हुनुभएको छ ?
१) छैन
२) छ, सामान्य घाइते
३) छ, चिकित्सकद्धारा उपचार भइसकेको छ
४) छ, अस्पतालमा छ
५) उपचारका क्रममा मृत्यु भयो

२६. लिङ्ग
१) पुरुष
२) महिला

२७. तपाईं कति वर्ष हुनु भयो ?

टिप्पणी (केही सुझाव):

Seismic Intensity Questionnaire Survey
2015 Gorkha, Nepal Earthquake of April 25

We wish to express our deep sorrow and sincere condolences to the people affected by this earthquake. In this survey we ask how you felt the earthquake shaking and how was the damage to your dwelling and in your neighborhood. The purpose of this survey is to estimate shaking intensity in each location. The result will be analyzed and used for planning better restoration and for mitigating future earthquake losses. We appreciate your kind cooperation.

Nepal-Japan Joint Reconnaissance Team
Co-team leader: Dr. Ramesh GURAGAIN, NSET-Nepal
Co-team leader: Assoc. Prof. Hitomi MURAKAMI, Yamaguchi University, Japan
Assoc. Prof. Shinichiro MORI, Ehime University, Japan

Contact address: Phone:

NOTES: Please answer the conditions of your location and the neighborhood of about **10 minutes' walk**.
Please check a SINGLE CATEGORY in each question.

Main shock (Apr. 25th) or Aftershock (May 12nd): 1) Main shock 2) Aftershock

Investigator: _____ Survey Date & Time: 24 June 2015

Q2. Where were you when the earthquake occurred?
Address:
City/Town/Village:
District:

Q3. How did you notice the shaking?
1) I was not certain whether or not it was an earthquake.
2) I realized at once it was an earthquake.
3) I felt it difficult to stand.
4) I was not able to stand.
5) I was thrown down. [-9]

Q4. How did you feel the ground shaking?
1) As slightly as one hardly felt. [-2]
2) As a light truck passing by. [3]
3) As a heavily loaded truck passing by. [4]
4) As a heavy object falling inside the building. [5]
5) As something exploding in the building. [7-]

Q5. Were you indoors or outdoors when the earthquake occurred?
1) Indoors
2) Outdoors → Please go to Q18, and answer the rest of questions.
3) In a vehicle → Please go to Q18, and answer the rest of questions.

Q6. What was the main material of the building?
1) Stone
2) Adobe
3) Brick
4) Wood and masonry (half-timbered structure)
5) Large block (including prefabricated type of structure)
6) Reinforced concrete

7) Others

Q7. How old was the building? ( ) years

Q8. How many stories did the building have? ( ) stories

Q9. On which floor of the building did you feel the earthquake?
1) Ground floor.
2) First floor
3) Second floor
4) Third floor
5) ( ) th floor

Q10. Were you frightened (in the building)?
1) No.
2) A little, but I felt safe even staying in the building.
3) Quite, but I felt it safe even staying in the building.
4) Almost scared.
5) Scared and did not know what I should do.
6) Panicked.

Q11. What happened to hanging objects, such as pictures on the wall and lights?
1) Nothing.
2) Slight swinging without noises.
3) Considerable swinging with banging noises, and some swung out of place.
4) Partly damaged or fallen.
5) Mostly damaged or fallen.
6) Practically every hanging object was damaged or fell.

Q12. What happened to objects on the shelf?
1) Nothing.
2) Some mover on the shelf.
3) Some fell from the shelf.
4) Most fell from the shelf.
5) Shelves fell.

Q13. What happened to furniture?
1) Nothing.
2) Slight shake.
3) Considerable shakes.
4) Heavy furniture partly moved.
5) Heavy furniture mostly moved and partly overturned.
6) Mostly overturned and considerable damage occurred.

Q14. What kind of noises did you hear during the earthquake?
1) Nothing.
2) Rattle of windows, doors, and dishes and/or creak of walls and floors.
3) Banging of doors and windows and/or creak from every part of the building.
4) Banging, creaking, and crushing noises filled in the building.

Q15. What happened to the plaster (of your building)?
1) No damage.
2) Fine cracks, and/or small pieces of plaster fell.
3) Large pieces of plaster fell here and there.
4) Large pieces of plaster fell everywhere.
5) The whole faces of plaster fell here and there.

Q16. What happened to the outer walls (of your building)?
1) No damage.
2) Small cracks.

3) Large and deep cracks.
4) Gaps.
5) Collapse in a single face and/or corner.
6) Collapse in two or more faces and/or corners.

Q17. What happened to the water tanks of your building?
1) No damage.
2) Little damages and deformed.
3) Heavy damages.
4) Destroyed.

Q18. What happened to the chimneys in your neighborhood?
1) No damage.
2) Some cracks in chimneys.
3) Some chimneys fell.
4) Most chimneys fell.

Q19. How was the damage to street brick walls in your neighborhood?
1) No damage.
2) Some small cracks.
3) Some had large cracks.
4) Some fell.
5) Most fell.

Q20. What was the damage level to the adobe (mud brick) houses in your neighborhood?
1) No damage.
2) Small cracks on walls
3) Damages in the outer walls and roofs, but the building kept its inner space.
4) Falls of the outer walls, but the building kept its inner space.
5) Some collapsed.
6) Many collapsed.

Q21. What was the damage level to the brick buildings in your neighborhood?
1) No damage.
2) Small cracks on walls
3) Damages in the outer walls and roofs, but the building kept its inner space.
4) Falls of the outer walls, but the building kept its inner space.
5) Some collapsed.
6) Many collapsed.

Q22. What was the damage level to the Reinforced Concrete buildings in your neighborhood?
1) No damage.
2) Some cracks of infill walls.
3) Some cracks of RCC columns or beams.
4) Damages in the walls and roofs, but the building kept its inner space.
5) Some collapsed.
6) Many collapsed.

Q23. What happened to the roads?
1) No damage.
2) Slight damage, but motor vehicles were able to go at normal speed.
3) Moderate damages, and motor vehicles often had to slow down.
4) Heavy damages, and motor vehicles always had to go slowly.
5) Motor vehicles were not able to go, but bicycles were able to go.
6) Only walkers were able to go.

Q24. What was the ground deformation?
1) Nothing.

2) Narrow cracks.
3) Cracks as wide as your toe might enter.
4) Cracks as wide as your foot might enter.
5) In addition to wide cracks, vertical and/or horizontal deformation.
6) Many extensive vertical and/or horizontal deformation.

Q25. Were you or your families trapped in the building?
1) No.
2) Yes. Family member can get you or your family out.
3) Yes. Relatives or neighbors could rescue you or your family.
4) Yes. Rescue teams, police, military, etc. could rescue one
5) Yes. One could not be rescued.

Q26. Were you or your families injured due to the earthquake?
1) No.
2) Yes, lightly injured.
3) Yes, treated by a doctor.
4) Yes, hospitalized.
5) Deceased (killed)

Q27. Sex: 1) male 2) female

Q28. How old are you? ( ) years

COMMENTS

Annex VI: Intensity by Location and Calculated Intensity in MMI (maximum, average and minimum values)

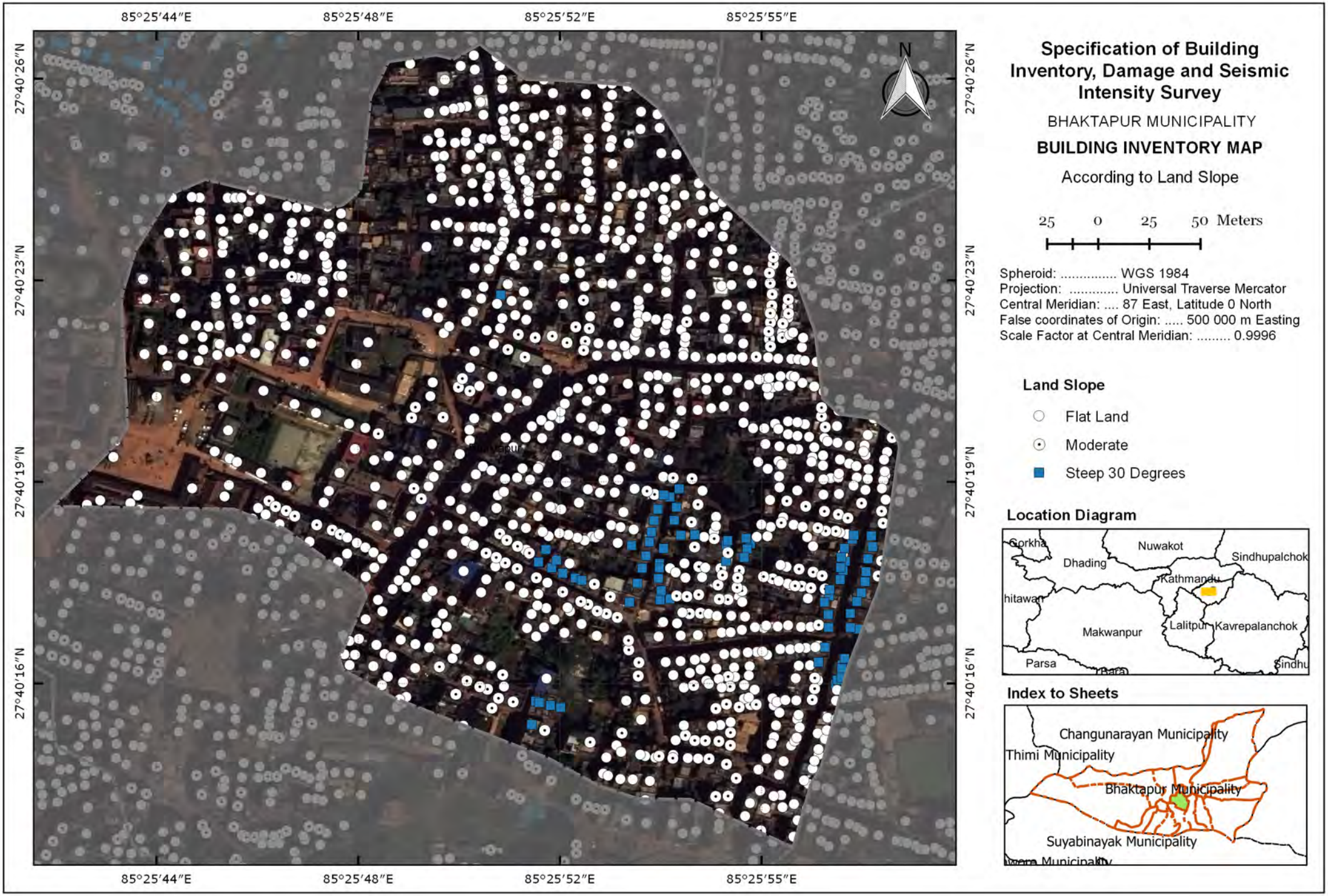
SN	Name of Settlement	Lattitude	Longitude	MAX	AVG	MIN
1	Salmechakal	27.3851	85.5007	7.8	7.8	7.8
2	Milche	27.4223	85.4326	5.3	5.3	5.3
3	Khopasi	27.5676	85.5342	6.2	5.8	5.5
4	Lele	27.5700	85.3400	7.1	6.8	6.4
5	Tikavairab	27.5753	85.3134	5.2	5.2	5.2
6	Panauti	27.5829	85.5097	7.0	5.8	5.1
7	Chaimale	27.5901	85.2601	6.7	6.3	5.8
8	Godawari	27.6016	85.3653	6.8	6.1	5.7
9	Daman	27.6083	85.0943	7.2	6.5	6.0
10	Dhulikhel	27.6164	85.5500	7.3	6.3	5.4
11	Badegaun	27.6172	85.3536	5.9	5.9	5.8
12	Thecho	27.6200	85.3200	6.2	5.8	5.5
13	Lamatar	27.6292	85.3989	6.0	5.7	5.4
14	Banepa	27.6335	85.5278	7.1	6.0	5.2
15	Harisiddhi	27.6389	85.3421	7.1	6.3	5.8
16	Lubhu	27.6396	85.3679	6.5	5.9	4.8
17	Bairikhel	27.6396	85.4318	6.4	6.4	6.4
18	Khokana	27.6399	85.2902	6.9	5.7	4.9
19	Dadikot	27.6407	85.3990	7.2	6.1	5.9
20	Gundu	27.6413	85.4151	6.0	6.0	6.0
21	Saga	27.6417	85.4777	6.9	6.3	5.7
22	Chalnakhel	27.6426	85.2749	6.8	6.3	5.7
23	Siddhipur	27.6452	85.3575	6.0	6.0	6.0
24	Charkhandi	27.6471	85.3933	6.4	5.7	5.4
25	Khumaltar	27.6484	85.3253	5.9	5.9	5.9
26	Hokse	27.6493	85.6562	7.6	7.6	7.6
27	Palung	27.6501	85.0700	7.1	6.1	5.3
28	Panchkhal	27.6505	85.6169	8.1	6.5	5.2
29	sirutar	27.6559	85.3744	6.7	6.6	6.6
30	Sipadol	27.6565	85.4327	6.8	6.2	5.6
31	Tikathali	27.6569	85.3576	6.2	5.9	5.5
32	Chovar	27.6589	85.2915	6.6	5.9	5.4
33	Imadol	27.6601	85.3501	7.2	5.9	4.8
34	Machhegau	27.6604	85.2492	6.7	5.2	3.7
35	Balkot	27.6633	85.3783	7.9	6.3	5.6
36	Suryabinayak	27.6654	85.4256	6.7	6.2	5.4
37	Kalacha	27.6655	85.4301	6.0	6.0	6.0
38	Gwarko	27.6664	85.3330	6.4	5.7	4.7
39	Jagati	27.6665	85.4365	7.3	5.9	5.3
40	Tahamala	27.6689	85.4270	5.7	5.7	5.7
41	Mangalachhe	27.6699	85.4253	6.8	6.8	6.8

SN	Name of Settlement	Lattitude	Longitude	MAX	AVG	MIN
42	Tathali	27.6701	85.4704	6.2	5.6	5.2
43	Lakolache	27.6703	85.4306	6.8	6.8	6.8
44	Panga	27.6705	85.2813	6.5	6.5	6.5
45	Gahiti	27.6706	85.4304	6.8	6.8	6.8
46	Bhaktapur	27.6710	85.4299	6.9	5.8	5.1
47	Liwali	27.6711	85.4392	6.9	5.8	5.0
48	Kwachhe	27.6712	85.4302	6.2	6.2	6.2
49	Bharwacho	27.6715	85.4235	6.6	6.1	5.8
50	Jela	27.6718	85.4346	7.6	7.6	7.6
51	Dudhpati	27.6718	85.4220	5.4	5.4	5.4
52	Siddhapokhari	27.6719	85.4206	7.1	7.1	7.1
53	Tibhukche	27.6719	85.4359	6.1	6.1	6.1
54	Sallaghari	27.6720	85.4078	6.9	6.3	5.6
55	Golmadi	27.6725	85.4324	7.2	6.5	6.1
56	Itachhe	27.6728	85.4259	6.2	6.2	6.2
57	Srijananagar	27.6730	85.4040	6.9	5.9	5.2
58	Lalachhe	27.6732	85.4316	5.6	5.6	5.6
59	Thimi	27.6732	85.3854	7.2	5.9	4.8
60	Chyamhasingh	27.6734	85.4384	6.3	6.1	6.0
61	Chochhen	27.6738	85.4308	7.1	6.7	6.3
62	Tachpal	27.6739	85.4354	7.5	6.4	5.5
63	Gathaghar	27.6740	85.3741	6.0	5.8	5.3
64	Kausaltar	27.6745	85.3654	6.3	6.0	5.7
65	Byasi	27.6754	85.4300	6.3	6.0	5.5
66	Kamalbinayak	27.6761	85.4373	6.9	6.1	5.4
67	Dekocha	27.6763	85.4328	6.7	6.1	5.9
68	Sudal	27.6786	85.4816	6.7	6.4	5.9
69	Madhyapur Thimi	27.6792	85.3859	5.4	5.4	5.4
70	Kalighat	27.6795	85.4294	7.5	6.4	5.8
71	Tinthana	27.6847	85.2684	6.5	6.5	6.5
72	Balkhu	27.6853	85.2945	6.2	5.8	5.4
73	Gurjudhara	27.6863	85.2415	5.5	5.5	5.5
74	Jaisithok	27.6867	85.6384	6.8	6.1	5.4
75	Byarak	27.6867	85.4486	6.3	6.3	6.3
76	Thankot	27.6867	85.2023	6.7	6.0	5.2
77	Jhaukhel	27.6900	85.4300	7.6	6.7	5.8
78	Duwakot	27.6905	85.4124	6.9	6.1	5.0
79	Kalanki	27.6932	85.2807	6.5	6.3	6.1
80	Kadhaghari	27.6949	85.3707	5.9	5.7	5.2
81	Saraswatikhel	27.6950	85.4030	6.4	5.9	5.4
82	Bageshwori	27.6965	85.4866	6.2	6.2	6.2
83	Gothatar	27.6999	85.3800	6.0	5.8	5.7
84	Pikhel	27.7076	85.4394	6.0	5.8	5.6
85	Mulpani	27.7102	85.3997	7.0	6.1	5.3
86	Telkot	27.7124	85.4749	6.4	5.8	5.2

SN	Name of Settlement	Lattitude	Longitude	MAX	AVG	MIN
87	Pipalbot	27.7125	85.4905	5.9	5.9	5.9
88	Changunarayan	27.7164	85.4279	7.2	6.3	5.7
89	Nagarkot	27.7170	85.5044	7.0	6.6	6.2
90	Sitapaila	27.7183	85.2746	6.4	6.1	5.8
91	Swayambhu	27.7192	85.2955	6.7	5.7	5.4
92	Banasthali	27.7214	85.2923	7.5	6.4	5.6
93	Ramkot	27.7237	85.2541	6.7	6.2	5.5
94	Jorpati	27.7279	85.3782	6.8	6.0	5.1
95	Sankhu	27.7292	85.4620	7.6	6.7	5.7
96	Balaju	27.7309	85.2955	6.8	6.1	5.6
97	Machhapokhari	27.7353	85.3058	6.1	6.1	6.1
98	Bhadrabas	27.7368	85.4234	7.7	6.5	5.3
99	Dhakalthok	27.7420	85.5937	6.5	6.1	5.3
100	Bhulbu	27.7435	85.4543	6.9	6.2	5.1
101	Nepaltar	27.7487	85.3007	6.4	6.1	5.5
102	Manamaiju	27.7490	85.3110	6.8	6.3	5.8
103	Gongabu	27.7499	85.3200	6.6	6.2	5.6
104	Aalapot	27.7500	85.4300	5.6	5.6	5.5
105	Dhapasi	27.7500	85.3301	6.7	6.0	5.2
106	Goldhunga	27.7600	85.2852	6.0	6.0	6.0
107	Gokarna	27.7668	85.4066	7.6	5.9	4.8
108	Phutung	27.7680	85.3124	6.3	6.3	6.3
109	Tokha	27.7698	85.3291	6.1	6.1	6.1
110	Badegau	27.7800	85.6103	5.8	5.7	5.7
111	Jitpurphedi	27.7801	85.2775	6.0	6.0	6.0
112	Sundarijal	27.7911	85.4273	7.1	6.1	5.3
113	Bansbari	27.8009	85.5561	5.8	5.6	5.5
114	Melamchi	27.8299	85.5765	7.7	6.6	5.4
115	Bidur	27.8901	85.1598	7.0	6.6	6.0
116	Nilkantha	27.9088	84.9402	7.2	6.6	5.9
117	Trisuli	27.9243	85.1403	7.3	6.3	5.7
118	Samari	27.9501	85.0500	7.0	7.0	7.0
119	Dhading	27.9718	84.8994	6.4	6.4	6.4
120	Betrawati	27.9745	85.2150	7.2	6.8	6.4
121	Chyangli	27.9838	84.4671	6.3	6.3	6.3
122	Palungtar	28.0140	84.4909	7.8	6.9	5.7
123	Dhhunche	28.1081	85.2981	7.9	6.8	5.8
124	Haku	28.1101	85.2400	7.1	6.6	5.9
125	Kharibot	28.2305	84.6584	5.4	5.4	5.4
126	Gorkha	28.4797	84.6909	7.1	6.3	5.6

Annex VII: List of participants in Trainings

Annex VIII: Specification Map Series of Building Inventory, Damage and Seismic Intensity Survey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85°25′52″E
85°25′55″E
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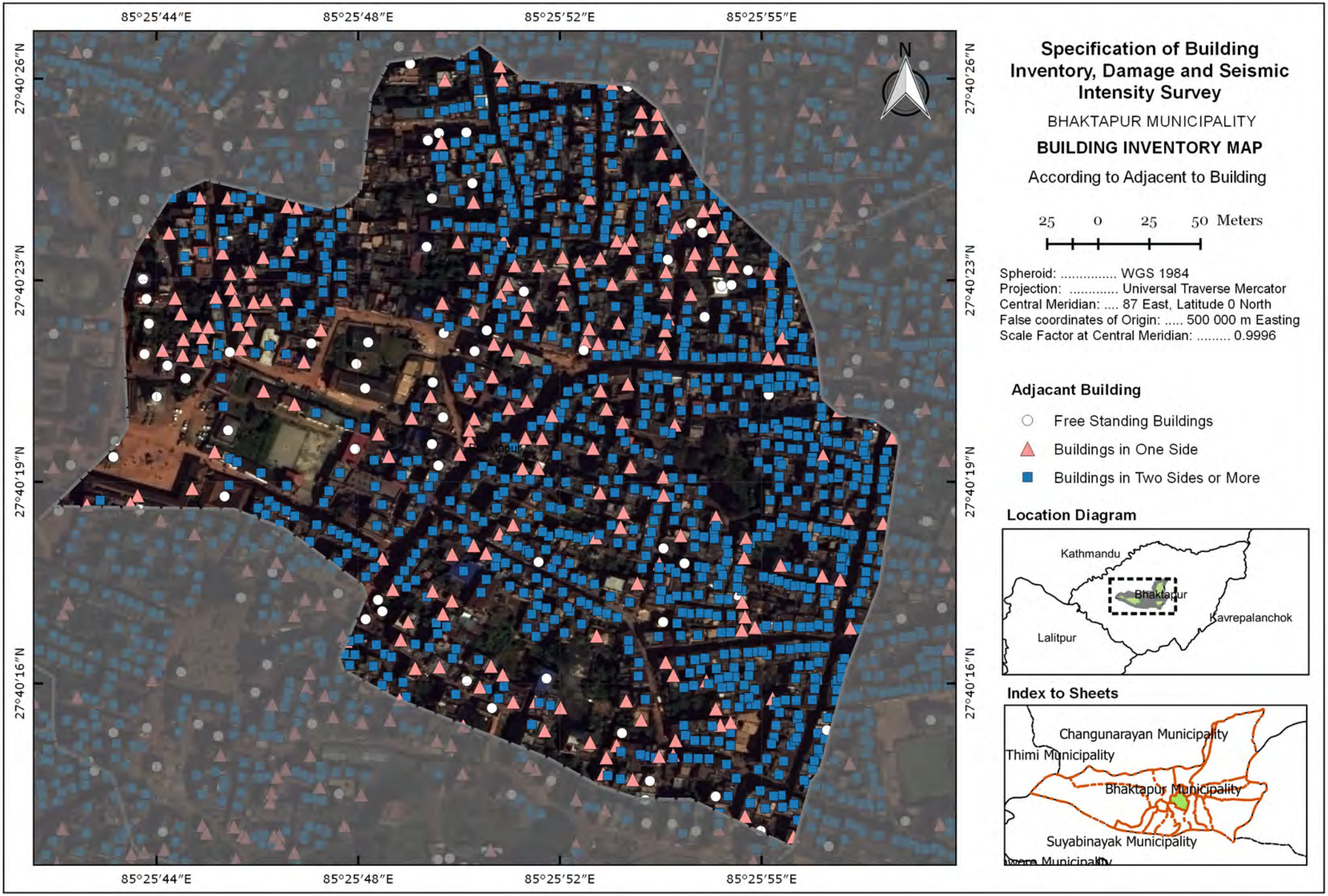
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Land Slope
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Land Slope
Flat Land
Moderate
Steep 30 Degrees
Location Diagram
Gorkha
Nuwakot
Dhading
Sindhupalchok
Kathmandu
Makwanpur
Lalitpur
Kavrepalanchok
Parsa
Sindhu
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality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27°40′26″N
27°40′23″N
27°40′19″N
27°40′16″N
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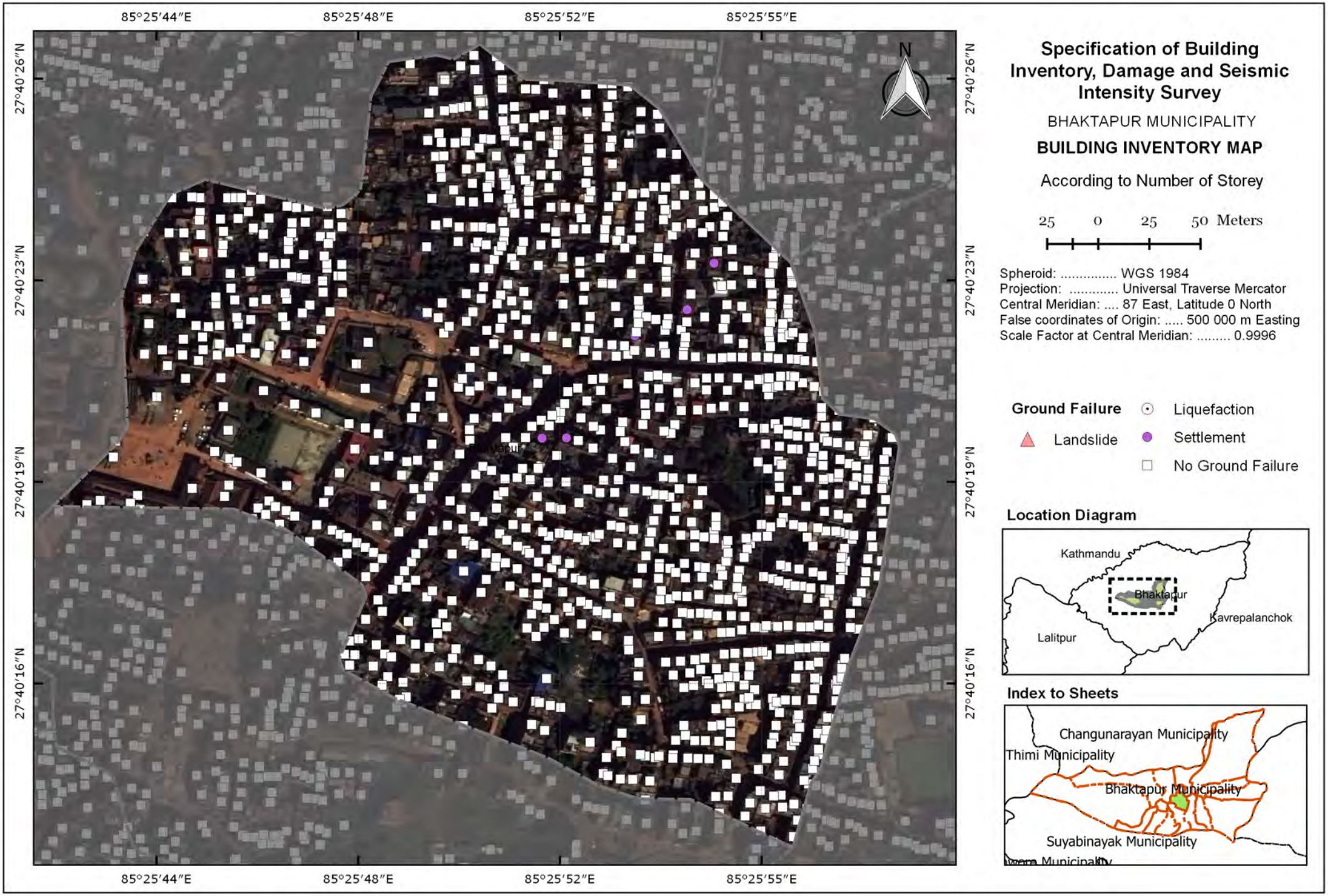
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Adjacent to Building
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Adjacant Building
Free Standing Buildings
Buildings in One Side
Buildings in Two Sides or More
Location Diagram
Kathmandu
Bhaktapur
Kavrepalanchok
Lalitpur
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality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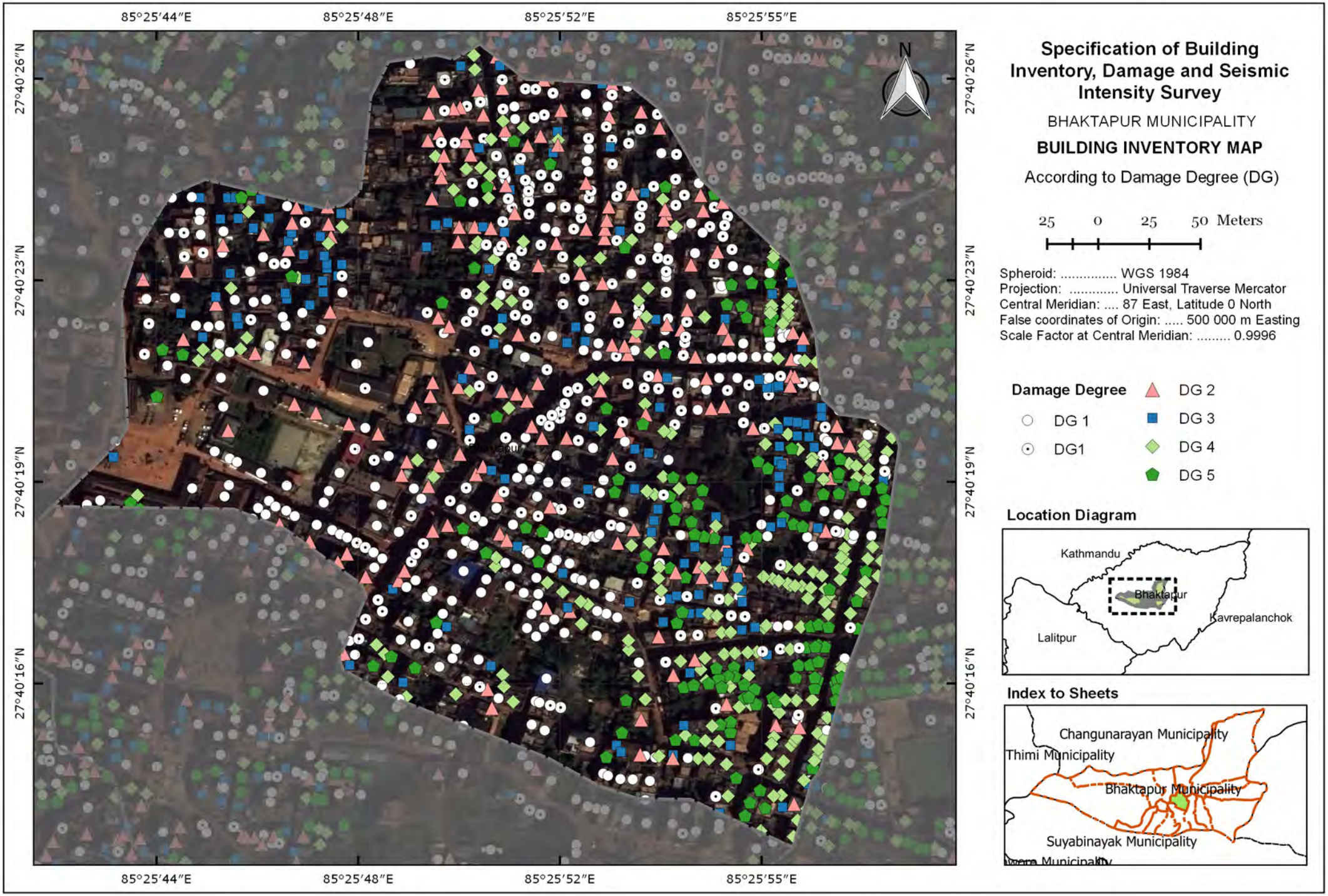
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Number of Storey
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Ground Failure
Liquefaction
Landslide
Settlement
No Ground Failure
Location Diagram
Kathmandu
Bhaktapur
Kavrepalanchok
Lalitpur
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality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27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Damage Degree (DG)
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Damage Degree
DG 1
DG1
DG 2
DG 3
DG 4
DG 5
Location Diagram
Kathmandu
Bhaktapur
Kavrepalanchok
Lalitpur
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality


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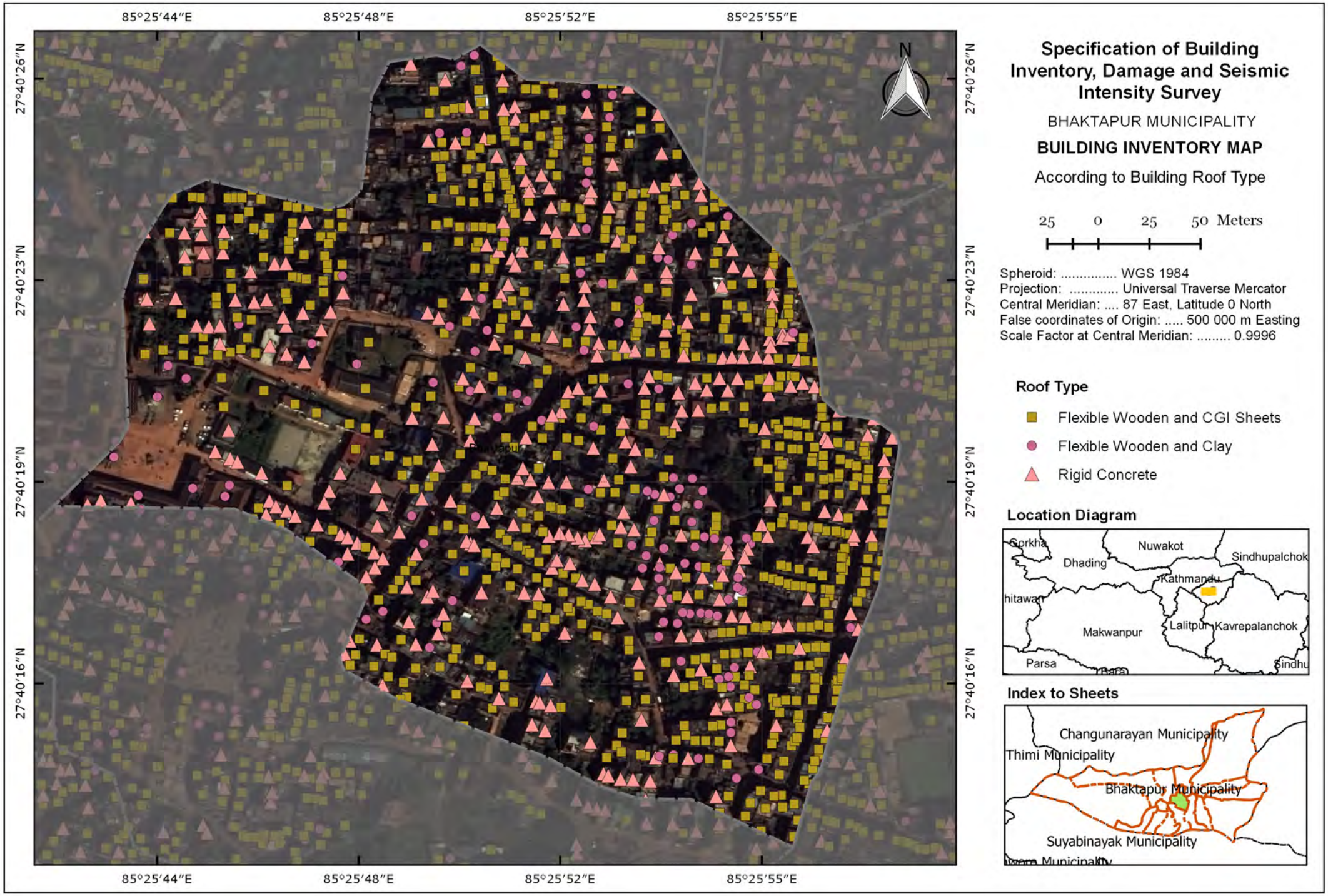
85°25′55″E
27°40′26″N
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Construction Period
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Construction Year
1_10Years
10_20Years
20_30Years
30_50Years
> 50 Years
Location Diagram
Gorkha
Nuwakot
Dhading
Sindhupalchok
Kathmandu
Makwanpur
Lalitpur
Kavrepalanchok
Parsa
Sindhu
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality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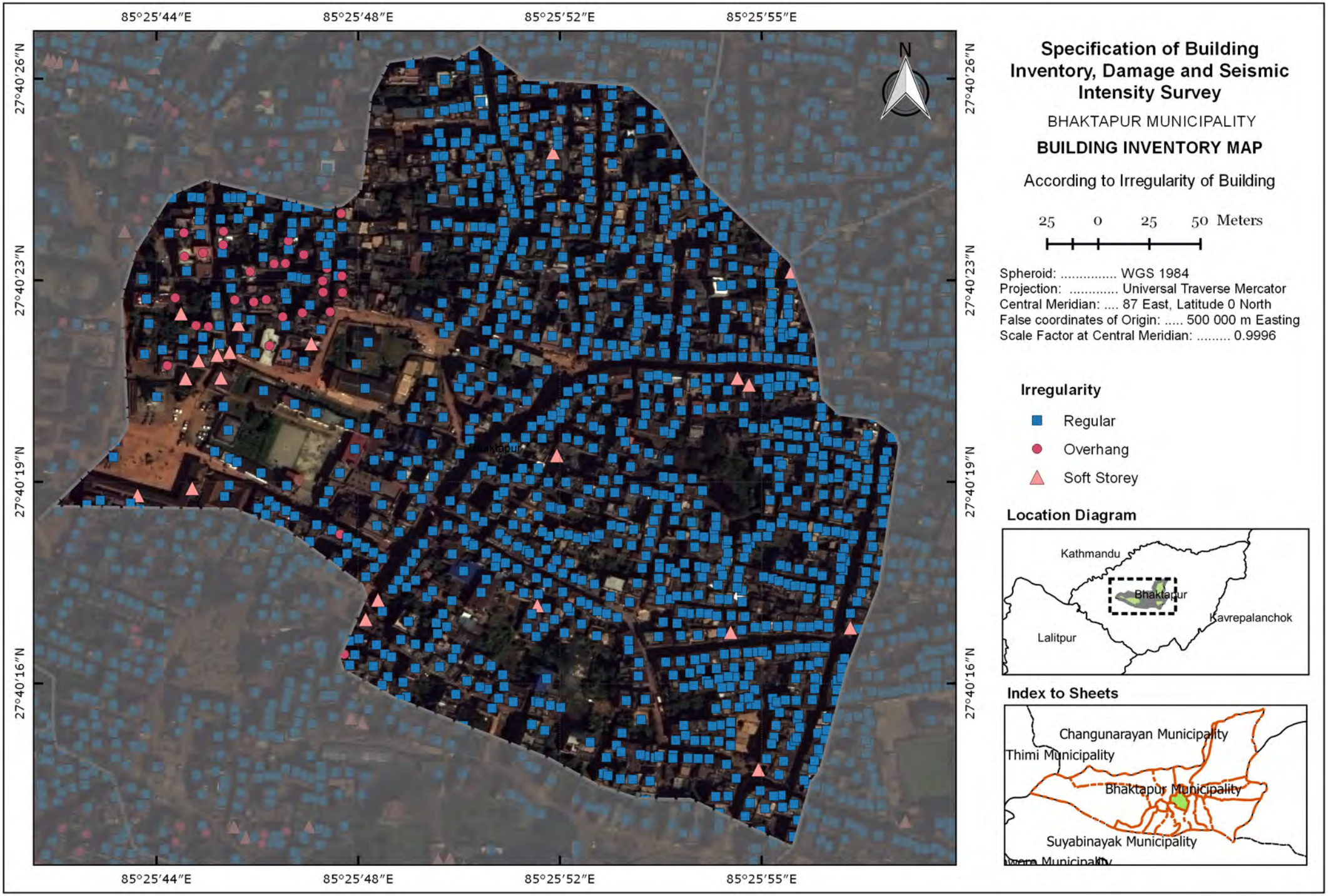
85°25′52″E
85°25′55″E
27°40′26″N
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Building Roof Type
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Roof Type
Flexible Wooden and CGI Sheets
Flexible Wooden and Clay
Rigid Concrete
Location Diagram
Gorkha
Nuwakot
Dhading
Sindhupalchok
Kathmandu
Makwanpur
Lalitpur
Kavrepalanchok
Parsa
Sindhu
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality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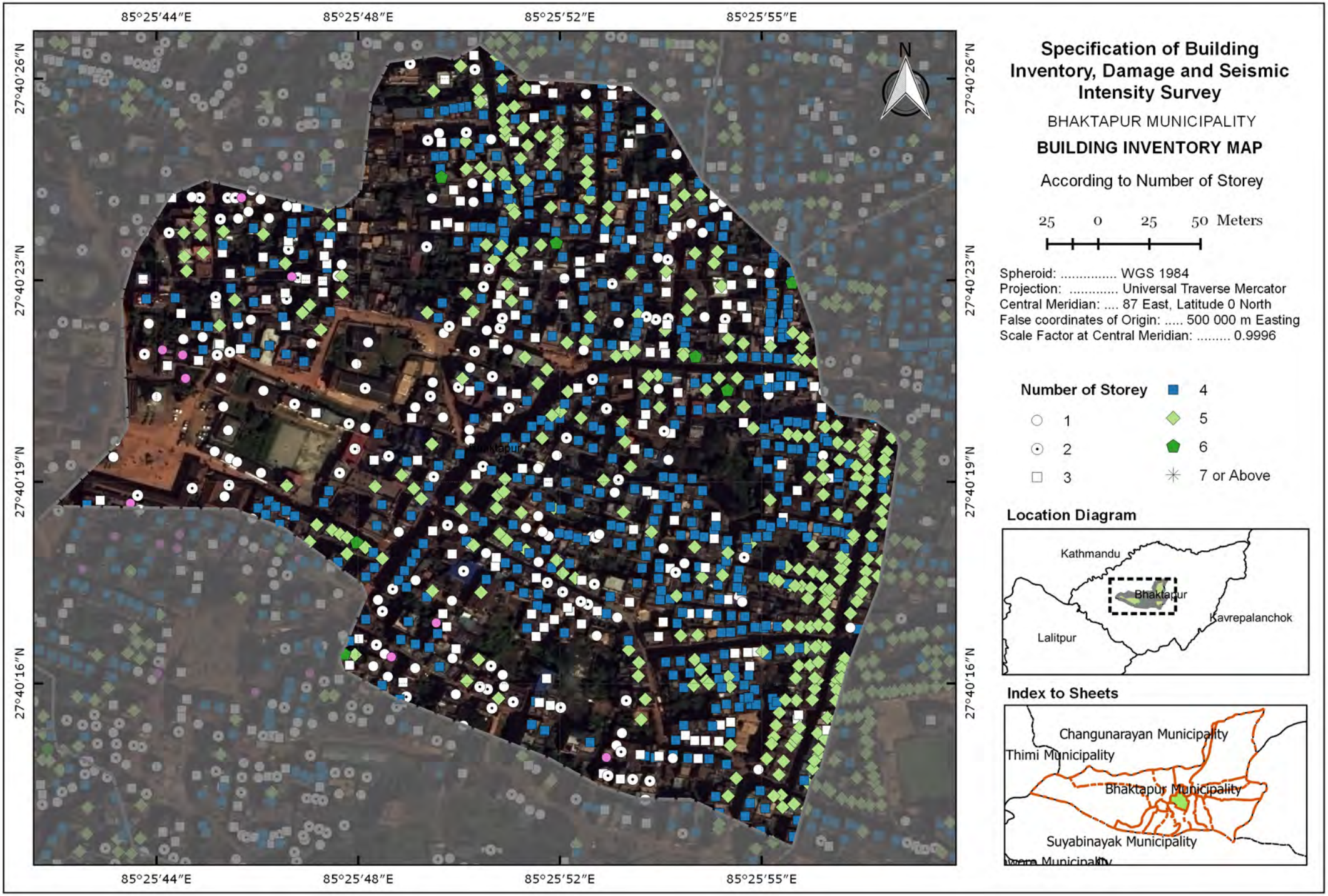
85°25′48″E
85°25′52″E
85°25′55″E
27°40′26″N
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Irregularity of Building
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Irregularity
Regular
Overhang
Soft Storey
Location Diagram
Kathmandu
Bhaktapur
Kavrepalanchok
Lalitpur
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality


85°25′44″E
85°25′48″E
85°25′52″E
85°25′55″E
27°40′26″N
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Structural Type of Building
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Structural Type
Adobe
Brick with Cement Mortar
Brick with Mud Mortar
Stone with Mud Mmortar
Stone with Cement Mortar
RC Frame Enginered
RC Frame Non-Engineered
Other Steel Wooden Frame
Others
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality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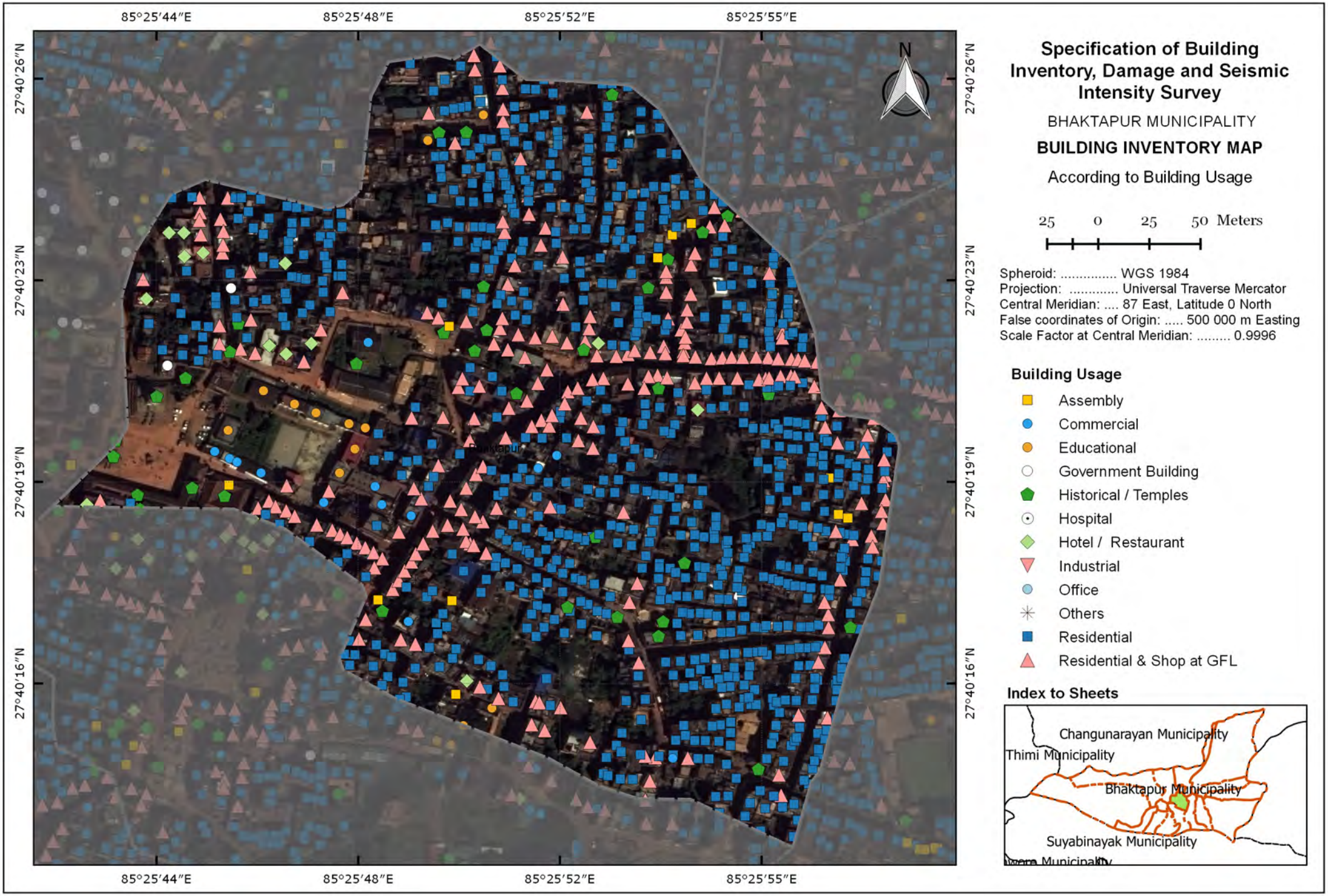
85°25′48″E
85°25′52″E
85°25′55″E
27°40′26″N
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Number of Storey
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Number of Storey
1
2
3
4
5
6
7 or Above
Location Diagram
Kathmandu
Bhaktapur
Kavrepalanchok
Lalitpur
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality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85°25′48″E
85°25′52″E
85°25′55″E
27°40′26″N
27°40′23″N
27°40′19″N
27°40′16″N
N
Specification of Building Inventory, Damage and Seismic Intensity Survey
BHAKTAPUR MUNICIPALITY
BUILDING INVENTORY MAP
According to Building Usage
25 0 25 50 Meters
Spheroid: ..... WGS 1984
Projection: ..... Universal Traverse Mercator
Central Meridian: .... 87 East, Latitude 0 North
False coordinates of Origin: ..... 500 000 m Easting
Scale Factor at Central Meridian: 0.9996
Building Usage
Assembly
Commercial
Educational
Government Building
Historical / Temples
Hospital
Hotel / Restaurant
Industrial
Office
Others
Residential
Residential & Shop at GFL
Index to Sheets
Changunarayan Municipality
Thimi Municipality
Bhaktapur Municipality
Suyabinayak Municipality

Report on Collection of Building Drawings and Related Information for Earthquake Risk Assessment of Kathmandu Valley

Activity 1 and 2

Submitted to:

ORIENTAL CONSULTANTS GLOBAL Co.Ltd. and OYO INTERNATIONAL CORPORATION JV
JICA Project Team, Kathmandu, Nepal

Submitted by:

EARTHQUAKE SAFETY SOLUTIONS
Bhaisepati Residential Area, Sainbu, Lalitpur
GPO Box: 13775, Kathmandu, Nepal
Telephone: (977-1) 55 90664 Fax: (977-1) 55 92 692
E-mail: ess@eqsafety.com.np
http://www.eqsafety.com.np

February 2016

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1 INTRODUCTION

1.1 General

JICA project team is implementing a project "Assessment of Earthquake Disaster Risk for Kathmandu Valley in Nepal". The main purpose of the project is the seismic risk assessment and the formulation of disaster risk management plan. In order to have idea on seismic performance of existing buildings, it is required to know the basic structural information, material properties and plan and elevations of representatives of existing buildings.

This report is on the collection of building drawings and related information of the representative of existing buildings for residential, hospital and school building in Kathmandu Valley of Activity 1 and Activity 2 as explained in Terms of Reference (TOR). This report is prepared by Earthquake Safety Solutions (ESS) as a part of contractual agreement between JICA Project team and ESS.

1.2 Objectives of work

The main purpose of this task is to collect building drawings of representative buildings in Kathmandu Valley and related informations.

1.3 Scope of Work

1. To collect the architectural and structural drawings of various types of buildings namely: adobe building, brick masonry with mud mortar and cement mortar building, RC soft story building, RC engineered building, school building, hospital building, historical building.
2. To calculate dead load and live load details on the floor of the building (kN/m^2)
3. To calculate seismic weight of the building.
4. To collect mortar strength for masonry building.
5. To collect information about the concrete and rebar strength for RC frame building.

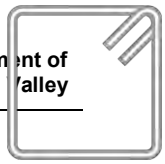
1.4 Approach / Methodology

The methodology adopted for the collection of building material and drawings is described in the following section.

1.4.1 Building Typology

Different typology of buildings can be found in Kathmandu Valley. To determine the earthquake risk of Kathmandu Valley, it is necessary to identify the typical building typology and their material properties. The typology of buildings that is prevalent in Kathmandu Valley is also identified by the JICA project team. The identified building typology according to use of building are as follows:

1. Residential Buildings
    a. Adobe
    b. Brick Masonry in Mud Mortar
    c. Brick Masonry in Cement Mortar



d. RC Soft Story Building by Non-Engineered Construction
e. RC framed by Engineered Construction
f. RC Frame High rise by Engineered Construction

2. School Building/Hospital Building
    a. Brick Masonry School Building
    b. Engineered RC Hospital Building
3. Historical Building
4. Governmental Building

1.4.2 Site Visit and Preparation of Drawings

The building drawings of identified typology was collected from different sources. Some drawings are prepared from archive of ESS that were prepared during Seismic Vulnerability Assessment of Buildings, some are prepared by conducting site survey and measurements at site and some are collected from municipality. The list of drawings collected from archive, site survey and municipality are listed in the Table 1:

Table 1: Sources of information for different building typology

S.N	Typology	Remarks
1	Adobe	Site survey and measurement
2	Brick Masonry in Mud Mortar	From archive
3	Brick Masonry in Cement Mortar	From archive
4	RC soft story with non-engineered construction	From archive
5	RC Framed by engineered construction	From municipality
6	RC Frame high rise by engineered construction	From the owner
7	Brick Masonry school building	From archive
8	RC Frame Hospital Building	From archive
9	Historical Building	Site survey and Measurement
10	Government Building	JICA Project Team

1.4.3 Collection of Material Information

The material information such as mortar strength in masonry building and concrete strength and rebar yield strength in Reinforced Frame building is collected from different source. The mortar strength for cement mortar and mud mortar are collected from the archive of ESS. Concrete strength for Non-engineered RC construction is assumed and is based on experience

while for RC engineered construction is design based. A core cutter test is carried out to determine the concrete strength in RC governmental building.

1.4.4 Load Calculation

The lumped load method is used for calculation of seismic weight. The seismic weight is calculated for each floor.

1.4.5 Collection of Damage Information

No survey forms were used for damage information collection. However, with visual assessment of some possible identified buildings were done and based on visual assessment and using Damage Classification by EMS, damage grades were also identified. Damage grade for buildings collected from Municipality were not specified.

2 GENERAL INFORMATIONS ON COLLECTED DRAWINGS

The location of all the buildings of which informations has been collected are shown in the google map as in the Figure 1.

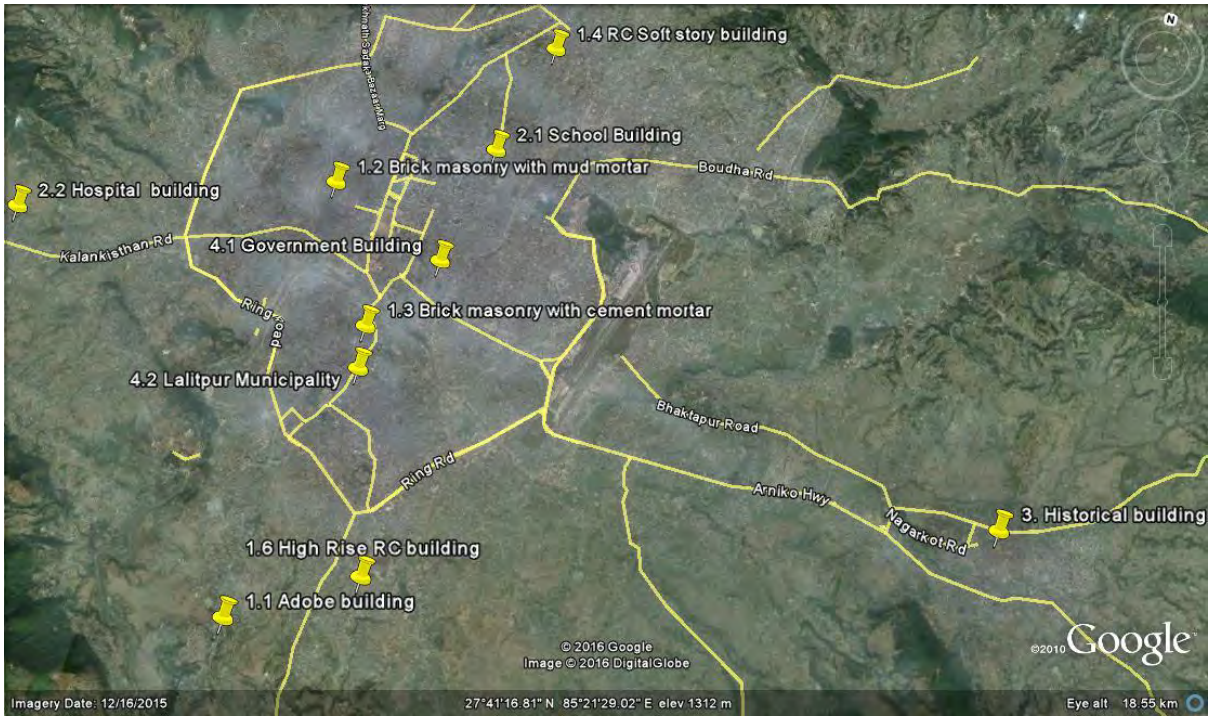


Figure 1. Location of the buildings for Activity 1 and Activity 2

2.1 Activity 1– Residential Building

2.1.1 Adobe building

2.1.1.1 General Description

Adobe is a building material made from earth and organic material. Adobe is among the earliest building materials, and is used throughout the world. An adobe brick is a composite material made of earth mixed with water and an organic material such as straw or dung. The soil composition typically contains sand, silt and clay. Straw is useful in binding the brick together and allowing the brick to dry evenly, thereby preventing cracking due to uneven shrinkage rates through the brick.

The selected building is a 3 story building, but due to the damage caused during the third story was removed and as per present condition it is a two story building with a CGI roof. The main wall is 450mm thick. The selected building is typical in adobe buildings found in Kathmandu Valley. The following are the building description:

Location	Khokana, Lalitpur, Nepal	
G.P.S.	27°38'13.80"N 85°18'19.62"E	

Terrain type	Plain terrain
Construction year	1976 A.D.
Type of structure	Adobe
No of stories	2
Plan configuration	Regular
Vertical configuration	Regular
Height up to ceiling	1.94m
Floor area	Ground Floor: 29.56 sq.m First Floor: 23.32 sq.m
Wall thickness	450mm
Shear Strength of Mortar	0.072 Mpa (From the previous test carried out on the adobe structure)
Building condition	Dismantled third floor, damage in External wall, damage in corners of walls
Floor/ Roof structure	Flexible floor of bamboo and mud, CGI roof.

East View of the Building

West View of the Building

2.1.1.2 Structural performance

This type of building is very weak in shear, tension and compression. Separation of walls at corner and junctions takes place easily under ground shaking. The cracks pass through the poor joints. After the walls fail either due to bending or shearing in combination with the compressive loads, the whole house crashes down. Extensive damage was observed during earthquake especially if it occurs after a rainfall.

The drawings are given in the Annex 3.

2.1.1.3 Damage Caused by Gorkha Earthquake

The following damages were caused due to the Gorkha earthquake:

- Shear cracks along the door window openings.
- More than 5 mm cracks were seen in the corners of the walls.

- Third story was damaged heavily due to Gorkha earthquake.
- Third story was removed and only two was present
- The observed damage grade is DG3 according to damage classification by EMS 98. (refer Annex 1 for damage grade information)

Figure 2. Crack formed in the corner due to Gorkha earthquake

2.1.1.4 Load details

Dead Load

The dead load due to soil on floor = 2.34kN/m^2

The dead load due to bamboo on floor = 0.065 kN/m^2

The dead load due to the full wall = 13.77kN/m

Live Load

The live load for the floor is LL = 1.5kN/m^2

Seismic weight

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor	354.69	8.745	363.435
Roof	145.43	4.10	149.53

The typical floor plan of the building is shown in the Figure 3

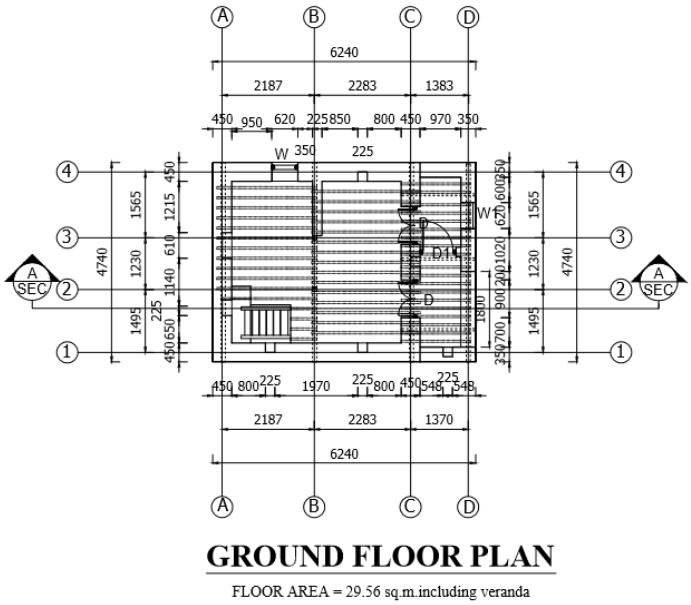


Figure 3. Floor plan of Adobe building

The floor area of each floor of the building is given in Table 2:

Table 2: Floor area of adobe

Floor	Area (sq.m)
Ground Floor	29.56
First Floor	23.32

2.1.2 Brick masonry with mud mortar

2.1.2.1 General Description

Generally, these types of building units such as brick or stone are joined together by the mud mortar. These types of building are very common in rural Nepal.

The selected building is a 4 story building with attic, it is a typical brick masonry with mud mortar, the building is a very old building which was built in about 172 years ago. The selected building is the typical building in this type. The following are the building descriptions:

Location	Basantapur, Kathmandu, Nepal	
G.P.S.	27°42'14.97"N 85°18'17.50"E	
Terrain type	Plain terrain	
Construction Year	1844 A.D.	

Type of structure	Load Bearing Brick Masonry with mud mortar	West View of the Building  South View of the Building
No of stories	Four Story + Attic	
Plan configuration	Regular	
Vertical configuration	Regular	
Height up to ceiling	2.52m at 1st floor and 2.2 m all other floors	
Floor Area	Ground Floor :63.82 sq.m First Floor: 63.82 sq.m Second Floor: 63.82 sq.m Third Floor: 63.82 sq.m	
Wall thickness	700mm, 650mm, 600mm	
Shear Strength of Mortar Joint	0.11 MPa (Derived from the mortar shear test done for similar structure)	
Building condition	Damage in Attic, External and Internal walls, corner separation	
Floor/ Roof structure	Flexible floor with wooden beam, brick and mud.	

2.1.2.2 Structural performance

These type of buildings are very heavy and attract large inertial forces. Masonry walls with mud mortar joints are weak against tension (Horizontal forces) and shear, and therefore, perform rather poor during earthquakes. These buildings have large in plane rigidity and therefore have low time periods of vibration, which results in large seismic force. These buildings fall apart and collapsed because of lack of integrity. The lack of structural integrity could be absence of bonding between cross walls, absence of diaphragm action of roofs and lack of box light action.

The drawings are given in the Annex 3.

2.1.2.3 Damage caused by Gorkha Earthquake

The following damages were caused due to the Gorkha earthquake:

- Spalling of mud plaster
- Shear cracks along the door window openings.
- More than 5 mm cracks were seen in the corners of the walls.
- Attic was greatly damaged.

- The observed damage grade is DG3 according to damage classification by EMS 98. (Refer Annex 1 for damage grade information).

Figure 4. Crack above the window due to Gorkha earthquake

2.1.2.4 Load details

Dead Load

The dead load of wooden beam = 0.33kN/m^2

The dead load of wooden plank = 0.26 kN/m^2

The dead load of brick layer = 0.76 kN/m^2

The dead load of earth filling = 0.90 kN/m^2

The dead load of 700mm thick full wall = 29.26kN/m

The dead load of 650mm thick full wall = 27.17kN/m

The dead load of 600mm thick full wall = 25.08kN/m

Live Load

The live load for the floor is LL = 2.5kN/m^2

Seismic Weight

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor level	629.96	36.38	663.34
2nd Floor level	647.83	36.66	684.49
3rd Floor level	665.9	40.20	706.1
Roof level	216.92	14.78	231.7

The typical floor plan of the selected building is shown in the Figure 5

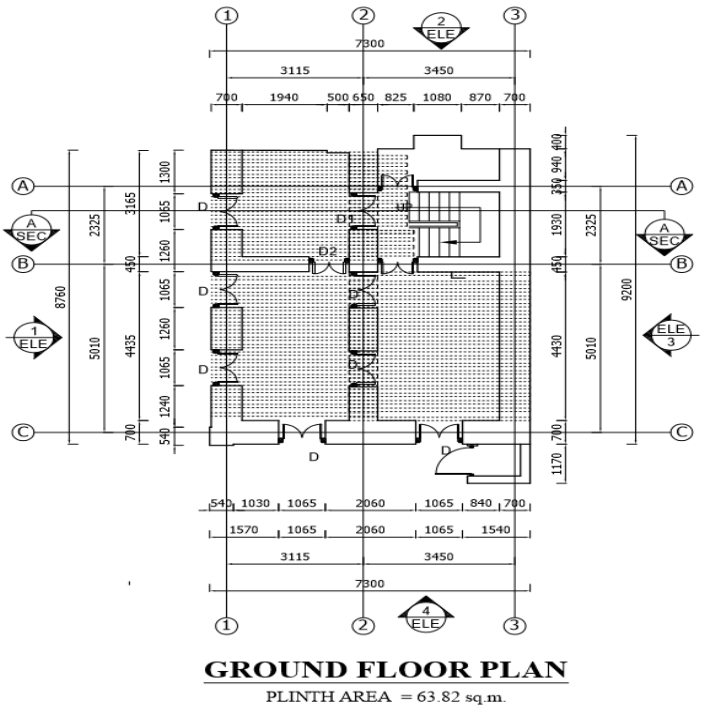


Figure 5. Ground floor plan of brick masonry with mud mortar building

The floor area of each floor of the building is given in the Table 3:

Table 3: Floor area of brick masonry with mud mortar joint building

Floor	Area (sq.m)
Ground Floor	63.82
First Floor	63.82
Second Floor	63.82
Third Floor	63.82

2.1.3 Brick masonry with cement mortar

2.1.3.1 General Description

Masonry buildings of brick with cement mortar joints are superior to that of the masonry building with mud mortar joints. The cement mortar provides more bonding to the bricks than the mud mortar. These types of building are very common in urban areas.

The selected building is a 3 story regular building, it is a typical brick masonry with cement mortar, the building which was built in 1978 A.D. The following are the building descriptions:

Location	Bakundole, Lalitpur, Nepal
G.P.S.	27° 40' 58.94" N, 85° 18' 58.43" E
Terrain type	Plain terrain
Construction year	1978 A.D.
Type of structure	Load Bearing brick masonry with cement mortar
No of stories	Three story
Plan configuration	Regular
Vertical configuration	Regular
Height up to ceiling	2.6m at ground floor, 2.55m at first floor and second floor.
Floor Area	Ground Floor: 111 sq.m First Floor: 111sq.m Second Floor: 104.7 sq.m Third Floor: 104.7 sq.m
Wall thickness	External wall 350mm brick wall Internal walls are 350, 225 and 100 mm brick walls
Shear Strength of Mortar	0.5 Mpa (derived from the previous test at ground floor)
Floor/ Roof structure	RCC 100 mm thick slab Flat roofs

North View of the Building

South View of the Building

2.1.3.2 Structural performance

These type buildings are very heavy and attract large inertia forces. Masonry walls with cement mortar joints superior to that of mud mortar but are also weak against tension (Horizontal forces) and shear, and therefore, perform rather poor during earthquakes.

These buildings have large in plane rigidity and therefore have low time periods of vibration, which results in large seismic force. These buildings fall apart and collapsed because of lack of integrity.

Performance of such type of building can be enhanced by providing the integrity, and making them to act as box like structure. Different types of bands and nominal reinforcement can be introduced to enhance the performance.

NOTE: If the selected building would have been of four storied as brick masonry with mud mortar building, there would be increase in seismic weight as well as the base shear to the building. Also, the building would be more vulnerable than three storied one.

The drawings are given in the Annex 3.

2.1.3.3 Damage Caused by Gorkha Earthquake

No damage was observed due to Gorkha Earthquake.

2.1.3.4 Load details

Dead Load

The dead load on floor due to RC slab = 2.5kN/m^2

The dead load due to the floor finish = 1.0 kN/m^2

The dead load due to 350 mm thick full wall = 17.29 kN/m

The dead load due to 225 mm thick full wall = 11.115 kN/m

The dead load due to 100 mm thick full wall = 4.94 kN/m

Live Load

The live load for the floor is LL = 2.5kN/m^2

Seismic Weight

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor level	1300.61	107.45	1408.06
2nd Floor level	1200.345	107.45	1307.795
Roof level	966.194	26.175	992.369

The typical floor plan of the building is shown in Figure 6

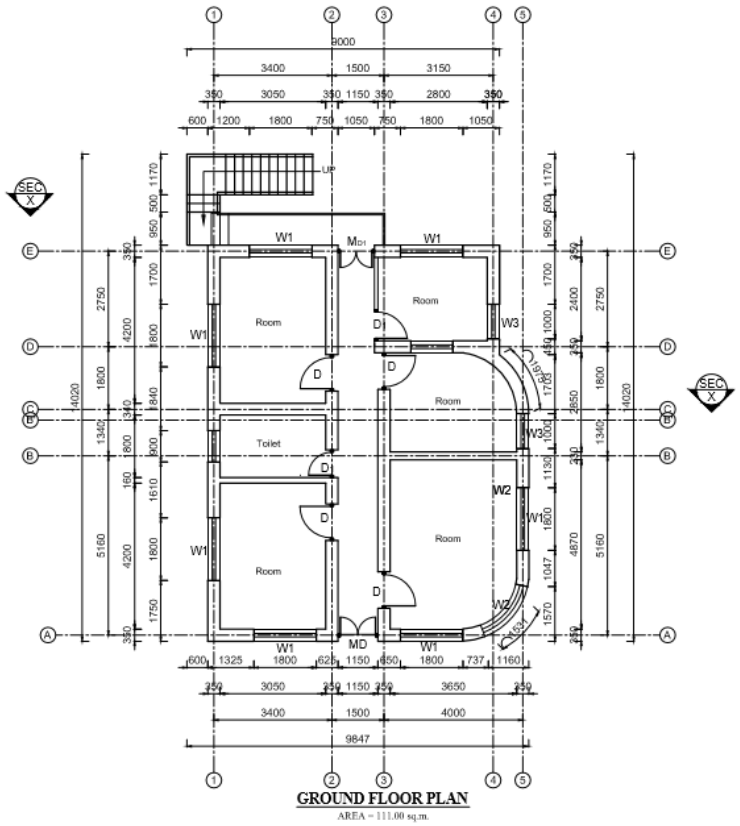


Figure 6. Floor plan of brick masonry with cement mortar building

The floor area of each floor of the building is given in the Table 3:

Table 4: Floor area of brick masonry with cement mortar joint building

Floor	Area (sq.m)
Ground Floor	111.0
First Floor	111.0
Second Floor	104.7
Third Floor	104.7

2.1.4 RC soft story building

2.1.4.1 General Description

This type of building consists of RC frame structures and brick masonry as infill to the frame. Ground floor generally kept open for various purposes such as for parking, commercial purpose etc. Due to the variation in stiffness in adjacent floors, the building generally do not perform well in earthquake.

The selected building is a 4 story RC frame building. It is a typical RC frame building with brick infills.

The following are the building descriptions:

Location	Maharajgunj, Kathmandu, Nepal
G.P.S.	27°43'57.78"N, 85°20'13.90"E
Terrain type	Plain terrain
Construction year	2004 A.D.
Type of structure	RC Frame non engineered structure
No of stories	Three Story
Plan configuration	Regular
Vertical configuration	Regular
Floor height	2.65m
Floor area	Ground Floor:70.18 sq.m. First Floor: 83.78 sq.m Second Floor: 84.51 sq.m Third Floor: 42.07 sq.m
Column size	225mmX 225mm
Wall thickness	225mm, 115 mm
Material Properties	Concrete Strength: 15Mpa (Assumed as it is very common) Yield strength of reinforcement: 415Mpa (This is the provided reinforcement)
Building condition	Damaged in the column in the ground floor due to soft story effect
Floor/ Roof structure	Rigid floor

North View of the Building

East View of the Building

2.1.4.2 Structural performance

RC frame building is ductile in nature but due to lack of ductility provided during the construction and also due to the difference in the lateral stiffness between the adjacent floors, the soft story failure occurs during the earthquake. This building has car porch at the ground floor with open floor while in upper floor the frames are stiffened by 230mm brick infill. This deficiency also results in concentration in damages in ground floors during Gorkha Earthquake also.

The drawings are given in the Annex 3.

2.1.4.3 Damage caused by Gorkha Earthquake

The following damages were caused due to the Gorkha earthquake:

- More than 5mm cracks in the ground floor column. All the damages was concentrated in ground floor only.
- Shear crack in infill walls.
- Cracks in beam column joints.
- The observed damage grade is DG3 according to damage classification by EMS 98. (refer Annex 2 for damage grade information)

Figure 7. Crack in columns of ground floor due to Gorkha earthquake

2.1.4.4 Load details

Dead Load

The dead load on floor due to RC slab = 2.5kN/m^2

The dead load due to floor finish = 1.0 kN/m^2

The dead load due to 225mm thick full brick wall = 11.33 kN/m

The dead load due to 115mm thick full brick wall = 5.79 kN/m

Live Load

The live load for the floor is LL = 2.5kN/m^2

Seismic Weight

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor level	751.87	52.36	804.23
2nd Floor level	836.05	52.82	888.87
3rd Floor level	708.40	15.78	724.18
Roof level	132.48	2.08	134.56

The typical floor plan of the building is shown in figure:

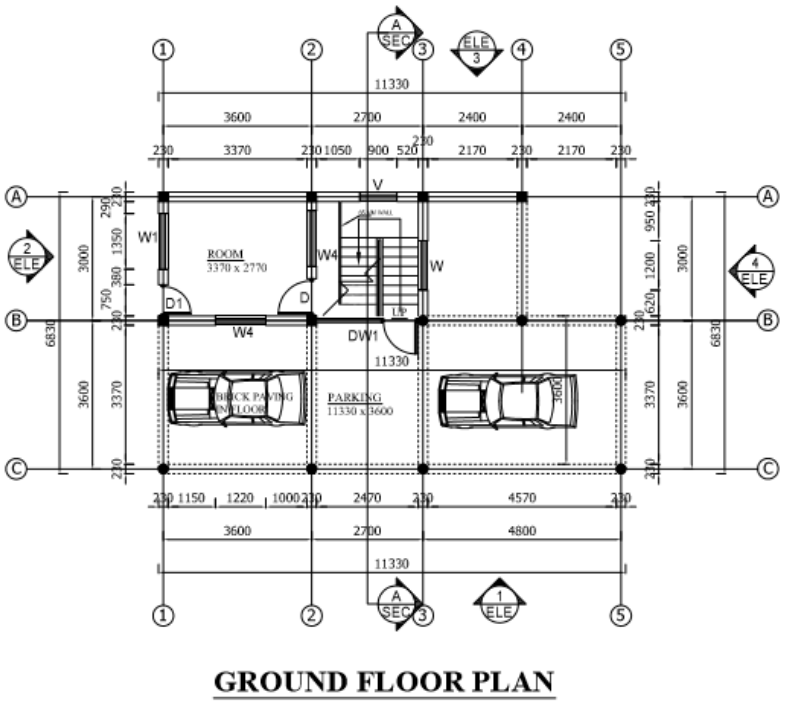


Figure 8. Floor plan of RC non engineered building

The floor area of each floor of the building is given in the Table 5:

Table 5: Floor area of the RC soft storied building

Floor	Area (sq.m)
Ground Floor	70.18
First Floor	83.78

Second Floor	84.51
Third Floor	42.07
Roof	16.665

2.1.5 RC frame by Engineered Construction

2.1.5.1 General Description

This type of building consists of RC frame structures. It is designed by the engineers and all the codal provisions are met during the design and also in the construction phase.

The selected building is a 4 story RC frame building. It is a typical RC frame building with brick infills.

The following are the building descriptions:

Location	Samakhushi, Kathmandu, Nepal
Terrain type	Plain terrain
Construction year	2013 A.D.
Type of structure	RC Frame structure by engineered construction
No of stories	Four Story and staircase cover
Plan configuration	Regular
Vertical configuration	Regular
Floor height	3.302m
Floor Area	Ground Floor: 126.41 sq.m. First Floor: 126.41 sq.m. Second Floor: 126.41 sq.m. Third Floor: 126.41 sq.m. Fourth Floor: 42.75 sq.m
Column size	400mmX 400mm
Wall thickness	225mm, 115 mm
Material Properties	Design strength: Compressive strength of concrete: 25Mpa for columns, 20 Mpa for all other structure

	Yeild strength of Rebar: 415 Mpa
Building condition	Well-conditioned
Floor/ Roof structure	125mm thick RC rigid floor

2.1.5.2 Structural performance

In this type of building (RC engineered) all the codal provisions are followed but they lack conceptual design and may result in poor performance in earthquake. However, buildings having good regular shape in plan and elevation and ductile detailing perform well in earthquake. Linear static analysis is done while designing of the building.

The drawings are given in the Annex 3.

2.1.5.3 Damaged Caused by Gorkha Earthquake

As the information for this typology is collected from Municipality, no information on damage due to Gorkha Earthquake is available. However, this building should not get any kind of damages with the intensity observed by Gorkha Earthquake at the location.

2.1.5.4 Used Design Code

Analysis- IS 1893:2002 part 1 for seismic loads

Seismic weight of the building =5719.3 kN

Seismic coefficient of the building = 0.9

Base shear = 514.73 kN

Design- IS 456:2000

Ductile Detailing- IS 13920

2.1.5.5 Load details

Dead Load

The dead load on floor due to RC slab = 3.13kN/m^2

The dead load due to screeding and finishing = 1 kN/m^2

The dead load due to floor marble = 0.68 kN/m^2

The dead load due to 225 mm thick full wall = 14.11 kN/m

The dead load due to 115 mm thick full wall = 7.21 kN/m

Live Load

The live load for the floor is LL = 2.5kN/m^2

Seismic weight

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor level	1294.15	79.0	1373.15
2nd Floor level	1215.72	79.0	1294.72

3rd Floor level	1332.57	79.0	1411.57
4th Floor level	1201.65	79.0	1280.65
Roof level	263.93	26.72	290.65

The typical floor plan of the building is shown in Figure 9.

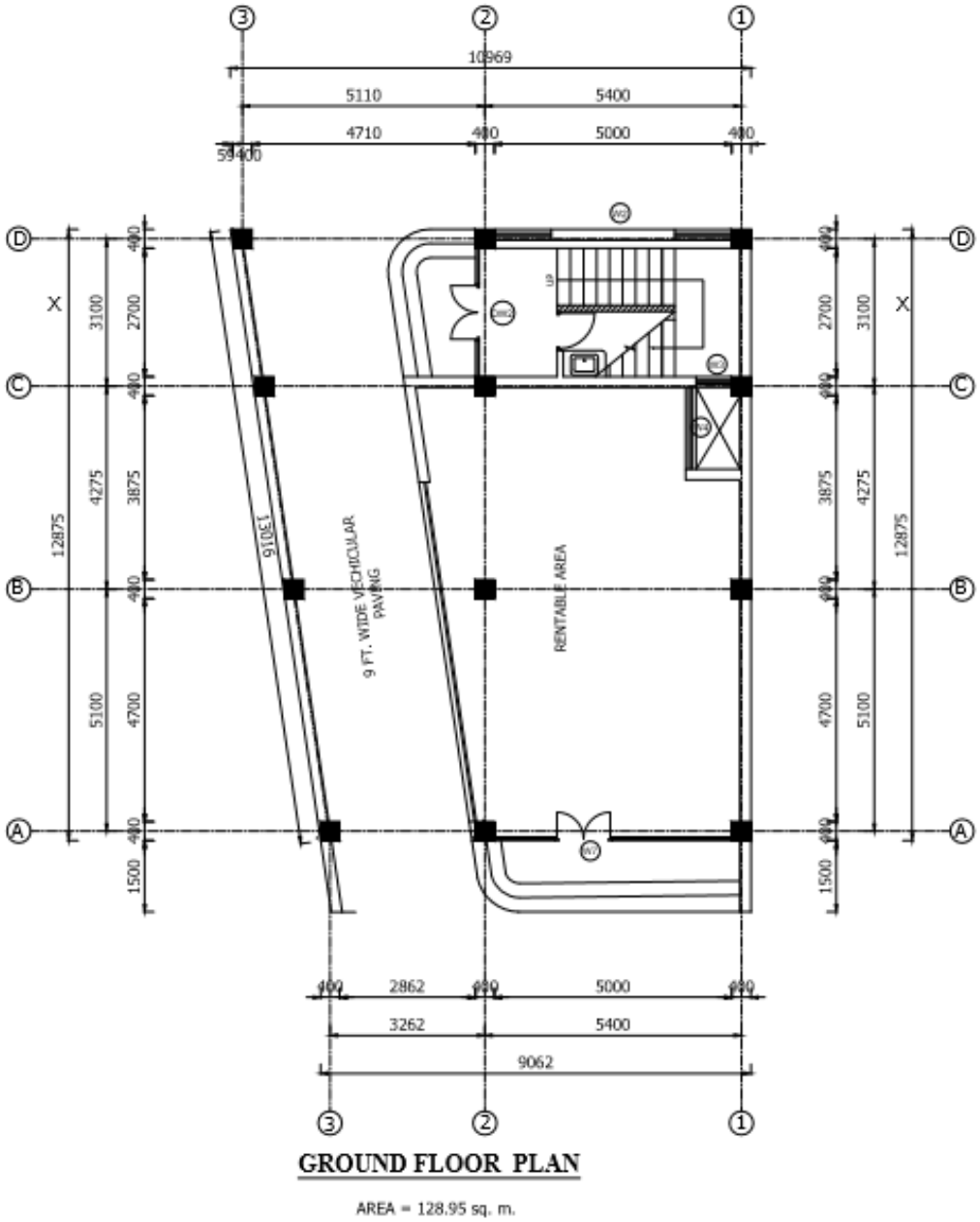


Figure 9. Floor plan of engineered building

The floor area of each floor of the building is given in Table 6:

Table 6: Floor area of each floor of the RC engineered building

Floor	Area (sq.m)
Ground Floor	126.4
First Floor	126.4
Second Floor	126.4
Third Floor	126.4
Fourth Floor	42.75

2.1.6 RC frame high rise by engineered construction

2.1.6.1 General Description

This type of building consists of RC frame structures. It is designed by the structural engineers. Since the building is a high rise building hence special design methods according to the codal provisions must be followed with modern techniques and state of art design must be followed.

The selected building is a 15 story RC frame building with basement. It is a typical RC frame high rise building.

The following are the building descriptions:

Location	Dhapakhel, Lalitpur, Nepal	 West view of the building
G.P.S.	27°42'27.00"N, 85°19'7.83"E	
Terrain type	Plain terrain	
Construction year	2011 A.D.	
Type of structure	RC Frame high rise structure	
No of stories	Fifteen with basement	
Plan configuration	Regular	
Vertical configuration	Regular	
Floor height	3.35 in Ground floor, other all floors 3.04 m	

Plinth Area	11104.1 sq.m.	South view of the building
Column size	Various, refer structure drawing	
Wall thickness	Shear walls 250mm and 300mm thick	
Material Properties	Concrete Strength (Design)- 30Mpa for columns only upto 2nd floor, 25 Mpa for column from 3rd floor to 10th floor, 20Mpa for column from 11th floor to roof For all other member (beam, slab, foundation, staircase and other concrete member except column) 20 Mpa concrete Yield strength of rebar: 415mpa	
Floor/ Roof structure	RCC 125mm slab floors and roof	

2.1.6.2 Structural performance

In this type of building (RC engineered) all the codal provisions are followed. However, due to lack of conceptual design resulting in configuration problem, these building may perform poor in earthquake. These buildings are designed using NBC 105 and IS 1893:2002, and these codes do not have lower bound for the base shear coefficient, most of the buildings are designed with very low base shear coefficient. The analysis method used in these structures is linear dynamic analysis.

The drawings are given in the Annex 3.

2.1.6.3 Damage Caused by Gorkha Earthquake

Moderate to severe cracks were observed after Gorkha Earthquake. But, the damage were already been repaired when we started this survey. The damage can be classified as DG2 according to EMS-98.

2.1.6.4 Used Design Code

Analysis- NBC 105 for seismic loads

Design- IS 456:2000

Ductile Detailing- IS 13920

2.1.6.5 Load details

Dead load

Dead load due to RC slab = 3.125kN/m^2

Dead load due to floor finishes = 1.5 kN/m^2

Dead load due to 225mm thick full wall = 12.91 kN/m

Dead load due to 115 mm thick full wall = 6.59 kN/m

Live load = 2 kN/m^2 on toilets on all floors

3 kN/m^2 on all floors and corridors

Seismic weight

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor level	11964.08	774.09	12738.17
2nd Floor level	12284.32	732.33	13016.65
3rd Floor level	12231.96	723.84	12955.8
4th Floor level	12223.92	722.535	12946.45
5th Floor level	12219.71	721.85	12941.56
6th Floor level	12224.33	722.60	12946.93
7th Floor level	11244.64	747.77	11992.41
8th Floor level	12212.91	720.75	12933.66
9th Floor level	12213.19	720.79	12933.98
10th Floor level	12220.77	722.025	12942.79
11th Floor level	12218.55	721.665	12940.2
12th Floor level	12218.55	721.665	12940.2
13th Floor level	12284.78	732.405	13017.18
14th Floor level	12264.11	729.05	12993.16
15th Floor level	7289.03	288.48	7317.51
16th Floor level	1534.43	51.41	1585.84
Roof level	1208.98	51.41	1260.39

The typical floor plan of the building is shown in Figure 10.

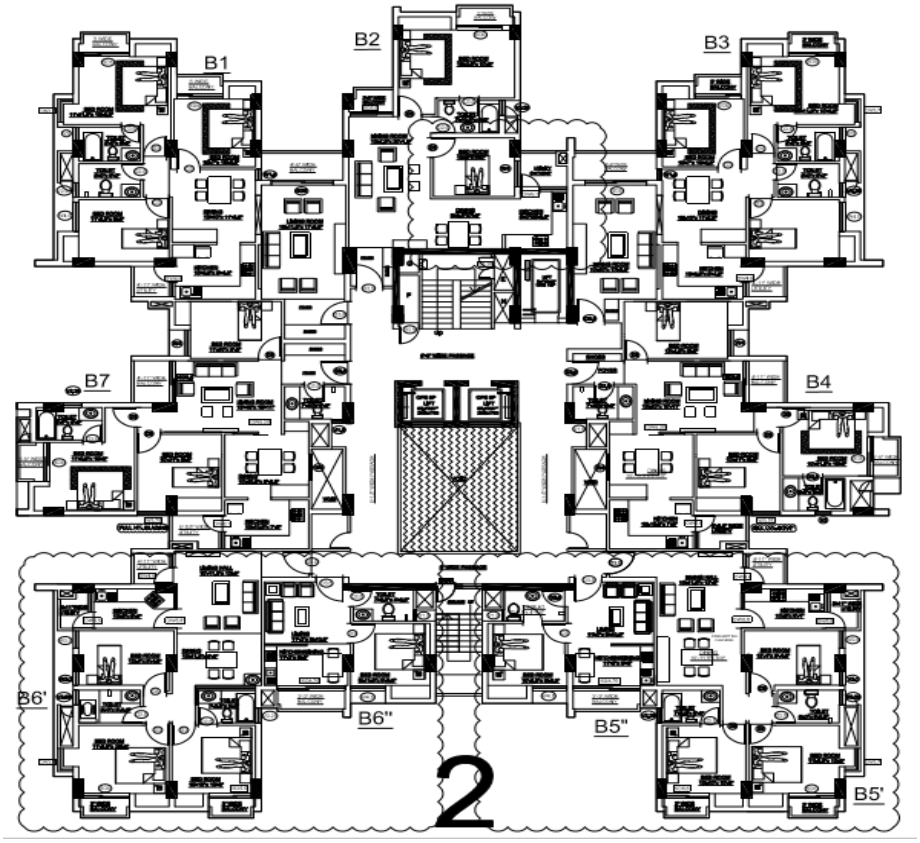


Figure 10. Typical floor plan of high rise RC building

The floor area of each floor of the building is shown in the Table 7:

Table 7: Floor area of each floor of RC high rise building

Floor	Area (sq.m)
Ground Floor	1032.13
First Floor	1032.13
Second Floor	976.44
Third Floor	965.12
Fourth Floor	963.38
Fifth Floor	962.47
Sixth Floor	963.47
Seventh Floor	997.03
Eighth Floor	961
Ninth Floor	961.06

Tenth Floor	962.7
Eleventh Floor	962.22
Twelveth Floor	962.22
Thirteenth Floor	976.54
Fourteenth Floor	972.07
Fifteenth Floor	769.28
Sixteenth Floor	137.1
Roof	137.1

2.2 Activity 2– School and Hospital Building

2.2.1 School Building

2.2.1.1 General Description

The selected building is a 3 story regular building. It is a typical brick masonry with cement mortar joint, the building which was built in 1977 A.D. The following are the building descriptions:

Location	Naxal, Kathmandu, Nepal
G.P.S.	27°42'51.81"N 85°19'51.37"E
Terrain type	Plain terrain
Construction Year	1977 A.D.
Type of structure	Brick masonry with cement mortar joint building
No of stories	Three story
Plan configuration	Regular
Vertical configuration	Regular
Story Height	Ground floor and first floor 2.625m, second floor 3.3m
Floor Area	Ground Floor: 181.44 sq.m First Floor: 177.59 sq.m Second Floor: 180.17 sq.m
Wall thickness	Ground floor walls 350mm, 230mm, and first floor and second floor walls 350mm, 230mm, 115mm
Material Properties	0.248 MPa (Derived from the mortar shear test done at ground floor)
Floor/ Roof structure	RCC 125mm slab

West View of building

2.2.1.2 Structural performance

These type buildings are very heavy and attract large inertia forces. Masonry walls with cement mortar joints superior to that of mud mortar but are also weak against tension (Horizontal forces) and shear, and therefore, perform rather poor during earthquakes.

These buildings have large in plane rigidity and therefore have low time periods of vibration, which results in large seismic force. These buildings get damaged and collapsed in earthquake because of lack of integrity.

Performance of such type of building can be enhanced by providing the integrity, and making them to act as box like structure. Horizontal and vertical bands and nominal reinforcement can be introduced to enhance the performance of the building during earthquake.

Since school buildings are used even after the earthquake as a relief centre or as a shelter for the homeless people, and also since in school small children in big number are there studying, hence school is kept as an important structure. Hence the importance factor of the school is taken as 1.5 while designing.

The drawings of the building are given in Annex 3.

2.2.1.3 Damage caused by Gorkha Earthquake

No damages were seen in the building.

2.2.1.4 Load details

Dead load

The dead load due to RC slab = 3.125kN/m^2

Finish load = 1.0 kN/m^2

Dead load due to 350mm thick full wall = 16.625 kN/m

Dead load due to 225mm thick full wall = 10.925 kN/m

Dead load due to 115 mm thick full wall = 5.46 kN/m

Live load

The live load for the floor is LL = 3.0kN/m^2

Seismic weight

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor level	1793.02	133.19	1926.21
2nd Floor level	1570.59	120.13	1690.72
Roof level	724.45	24.37	748.82

The typical floor plan of the selected school building is shown in Figure 11.

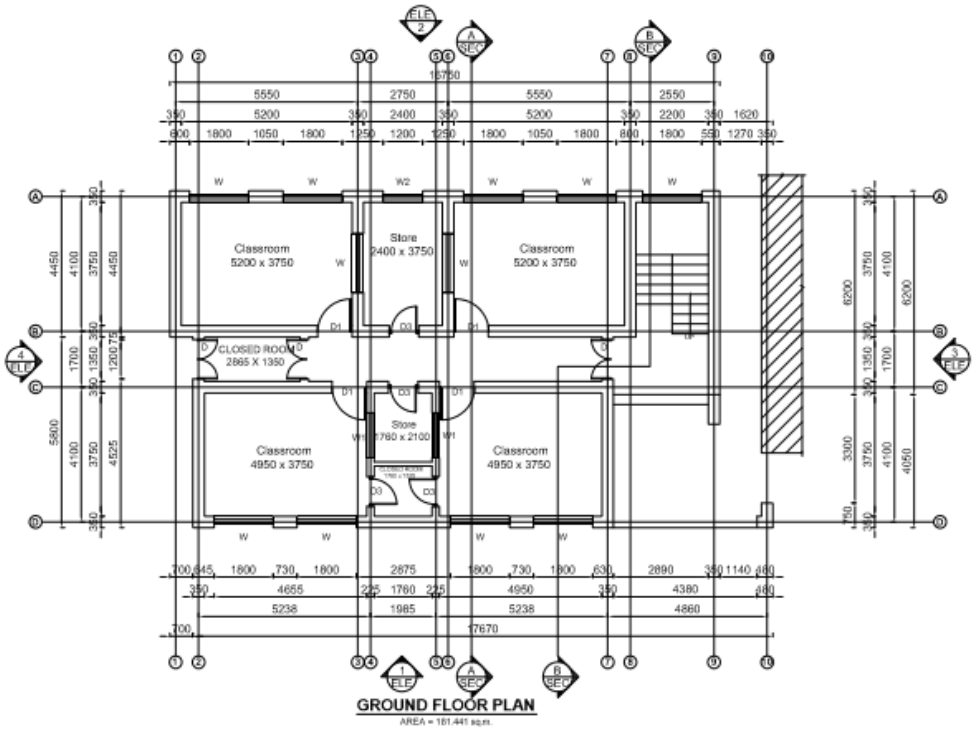


Figure 11. Floor plan of the school building

The floor area of each floor of the building is given in Table 8:

Table 8: Floor area of each floor of the school building

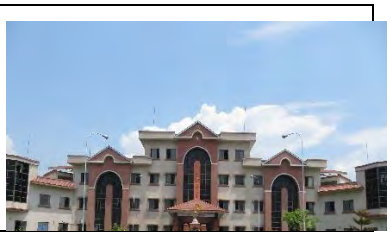
Floor	Area (sq.m)
Ground Floor	181.44
First Floor	177.59
Second Floor	180.17

2.2.2 RC frame Hospital Building

2.2.2.1 General Description

The selected building is a hospital building with RC frame construction. The building is a 4 story RC frame building.

The following are the building descriptions:

Location	Balambu, Kathmandu, Nepal	
G.P.S.	27°41'24.74"N 85°15'06.81"E	
Terrain type	Plain terrain	

Construction Year	2007 A.D.	Front view of building  Back view of right wing
Type of structure	RC Frame structure	
No of stories	Four Story	
Plan configuration	Regular	
Vertical configuration	Regular	
Floor height	4.0 m	
Floor Area of selected block	Ground Floor: 775.22 sq.m First Floor: 775.22 sq.m. Second Floor: 775.22 sq.m Top Floor: 775.22 sq.m Roof:336.98 sq.m	
Column size	450mm x 450mm and 500mm x 500mm	
Wall thickness	225mm, 115 mm	
Material Properties	Design compressive strength of Concrete: 20mpa with super plasticizer Yield strength of rebar: 415mpa	
Building condition	Well-conditioned	
Floor/ Roof structure	125mm thick RC rigid floor	

2.2.2.2 Structural performance

In this type of building (RC engineered) all the codal provisions are followed and the performance is very good. Ductile detailing is followed and hence building obtains its ductility. Limit state method is followed while designing. Linear static analysis is done while designing of the building. As hospitals need to be functional during and after the earthquake, the building is considered as more important building and important factor is taken as 1.5.

The drawings of the building are given in Annex 3.

2.2.2.3 Used Design Code

Analysis- NBC 105 for seismic loads

Design- IS 456:2000

Ductile Detailing- IS 13920

2.2.2.4 Damage Caused by Gorkha Earthquake

No damage was seen due to the Gorkha earthquake.

2.2.2.5 Load details

Dead load

The dead load due to RC slab = 3.75kN/m^2

The dead load due to Floor finish = 1.5 kN/m^2

Dead load due to full wall of 230mm thick = 14.64 kN/m

Dead load due to full wall of 115mm thick = 7.32 kN/m

Live Load

The live load for the floor is LL = 2.5kN/m^2

Seismic weight

For the seismic weight the centre block is considered, which is from the gridline 7 to 14. The wing blocks are separated with the gap hence the centre block is taken for the calculation of the seismic weight and the total lumped load on each of the floor level is also taken due to the centre block only.

Lumped mass at floor level	Dead Load (kN)	25% of Live Load (kN)	Total Lumped Load (kN)
1st Floor level	9761.355	581.415	10342.77
2nd Floor level	9795.332	581.415	10376.75
3rd Floor level	9043.515	581.415	9624.93
Roof level	3939.19	84.245	4023.435

The typical floor plan of the selected hospital building is shown in Figure 12

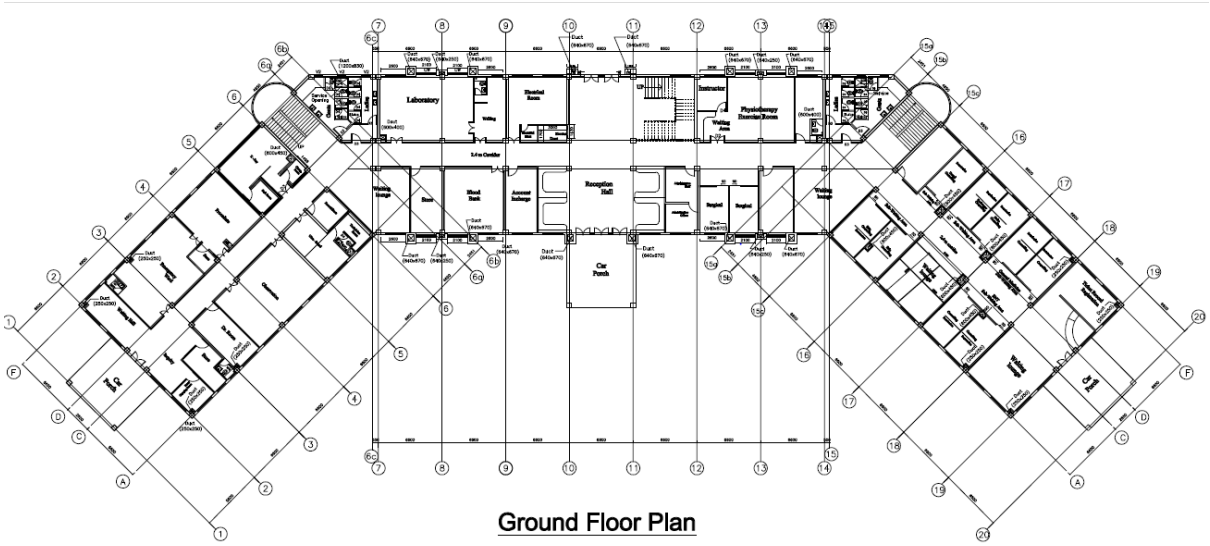


Figure 12. Floor plan of the hospital building

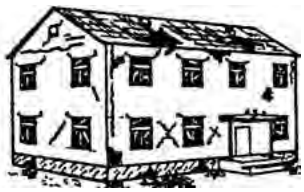
The floor area of each floor of the building is given in the Table 9:

Table 9: Floor area of each floor of RC Hospital building

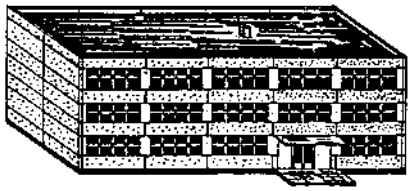
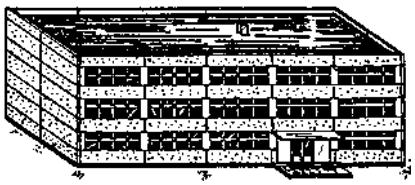
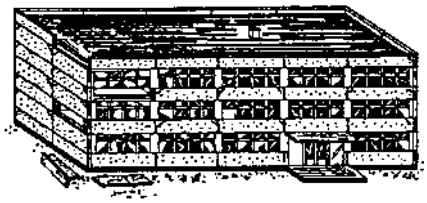
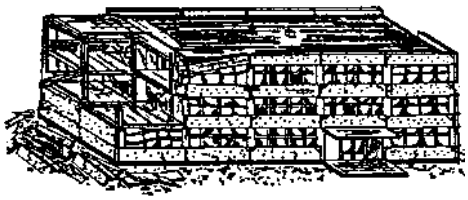
Floor	Area for the centre block (sq.m)
Ground Floor	775.22
First Floor	775.22
Second Floor	775.22
Top floor	775.22
Roof	336.98

ANNEXES

ANNEX 1. DAMAGE GRADE FOR MASONRY BUILDING BASED ON EMS-98

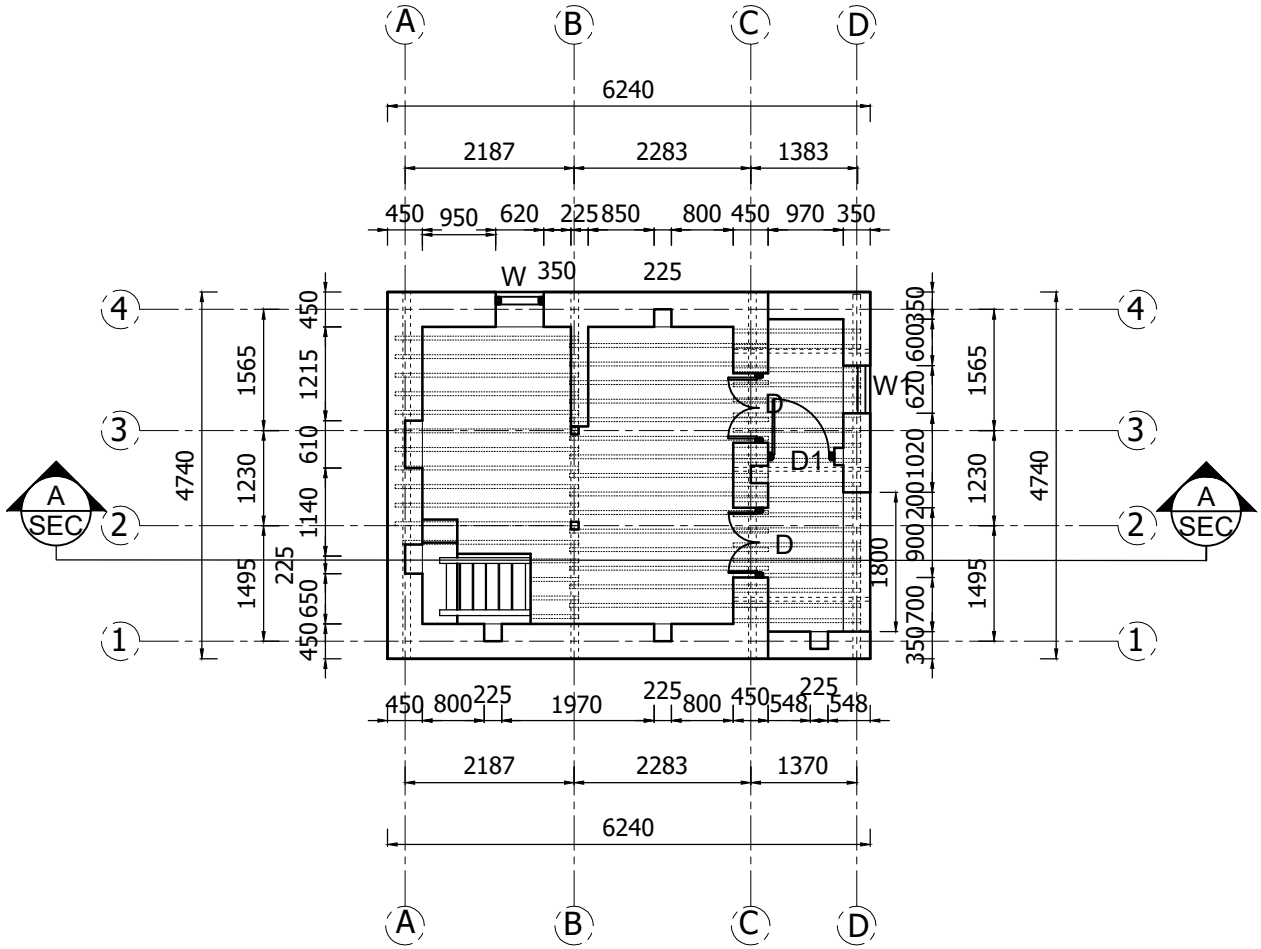
 **Grade 1: Negligible to slight damage**	**Structural damage: No** **Non-structural damage: Slight** • Hair-line cracks in very few walls. • Fall of small pieces of plaster only. • Fall of loose stones from upper parts of buildings in very few cases.
 **Grade 2: Moderate damage**	**Structural damage: Slight** **Non-structural damage: Moderate** • Cracks in many walls. • Fall of fairly large pieces of plaster. • Partial collapse of chimneys.
 **Grade 3: Substantial to heavy damage**	**Structural damage: Moderate** **Non-structural damage: Heavy** • Large and extensive cracks in most walls. • Roof tiles detach. • Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
 **Grade 4: Very heavy damage**	**Structural damage: Heavy** **Non-structural damage: Very heavy** • Serious failure of walls; partial structural failure of roofs and floors.
 **Grade 5: Destruction**	**Structural damage: very heavy** • Total or near total collapse.

ANNEX 2. DAMAGE GRADE FOR REINFORCED CONCRETE BUILDING BASED ON EMS-98

Classification of damage to buildings of reinforced concrete	
 **Grade 1: Negligible to slight damage**	**Structural damage: No** **Non-structural damage: Slight** • Fine cracks in plaster over frame members or in walls at the base. • Fine cracks in partitions and infills.
 **Grade 2: Moderate damage**	**Structural damage: Slight** **Non-structural damage: Moderate** • Cracks in columns and beams of frames and in structural walls. • Cracks in partition and infill walls; fall of brittle cladding and plaster. • Falling of mortar from the joints of wall panels.
 **Grade 3: Substantial to heavy damage**	**Structural damage: Moderate** **Non-structural damage: Heavy** • Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. • Spalling of concrete cover, buckling of reinforced bars. • Large cracks in partition and infill walls, failure of individual infill panels.
 **Grade 4: Very heavy damage**	**Structural damage: Heavy** **Non-structural damage: Very heavy** • Large cracks in structural elements with compression failure of concrete and fracture of re-bars; bond failure of beam reinforced bars; tilting of columns. • Collapse of a few columns or of a single upper floor.
 **Grade 5: Destruction**	**Structural damage: very heavy** • Collapse of ground floor or parts (e.g. wings) of buildings.

ANNEX 3. DRAWINGS

ADOBE
AT CHYASIKOT,
LALITPUR, NEPAL

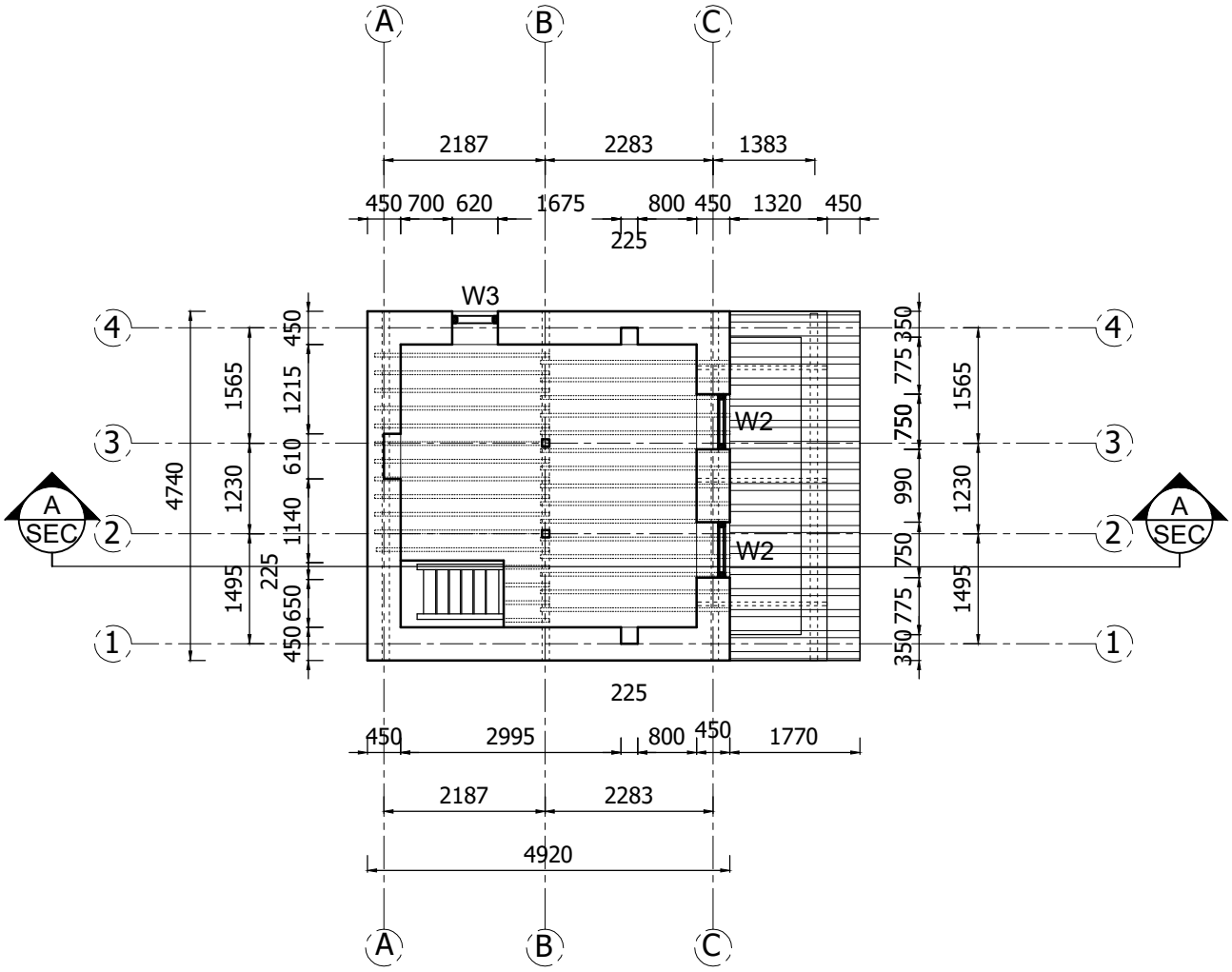


GROUND FLOOR PLAN

FLOOR AREA = 29.56 sq.m.including veranda

1 OF 8

Scale 1:100



FIRST FLOOR PLAN

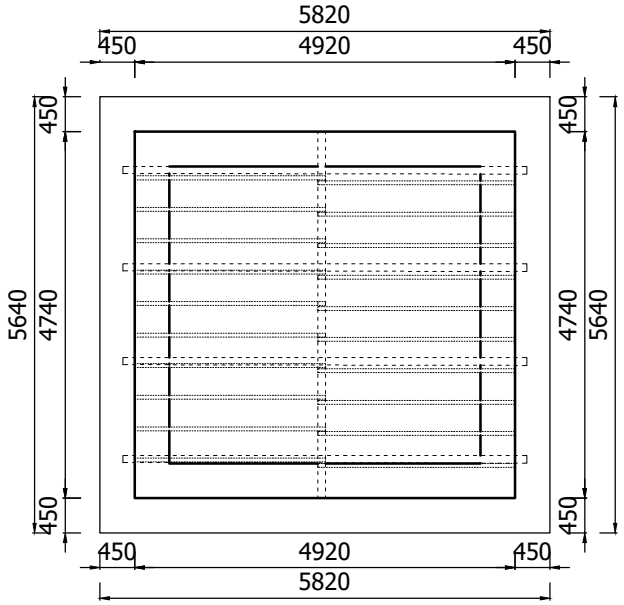
FLOOR AREA = 23.32 sq.m.

Scale 1:100

N

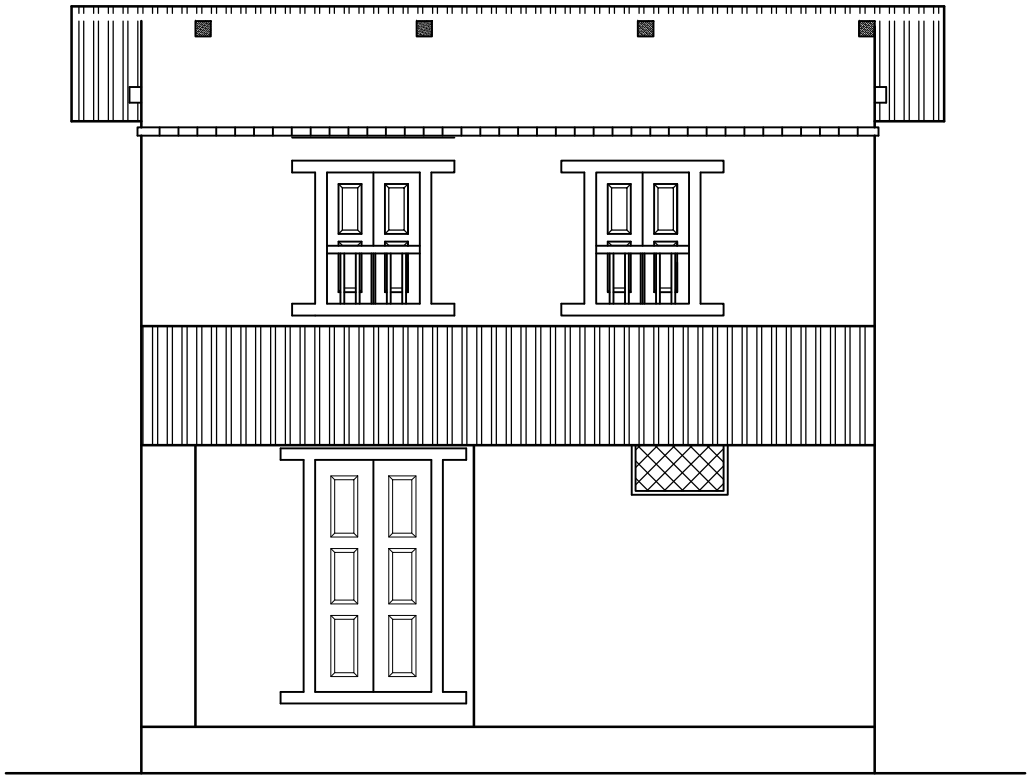
OPENING SHEDULE

NO.	DESCRIPTION	SYMBOL	SIZE	NOS.
1.	WINDOW	W	620 X 450	1
2.	WINDOW	W1	600 X 450	1
3.	WINDOW	W2	750 X 1000	2
4.	WINDOW	W3	620 X 1000	1
5.	DOOR	D	900 X 1650	2
6.	DOOR	D1	855 X1650	1



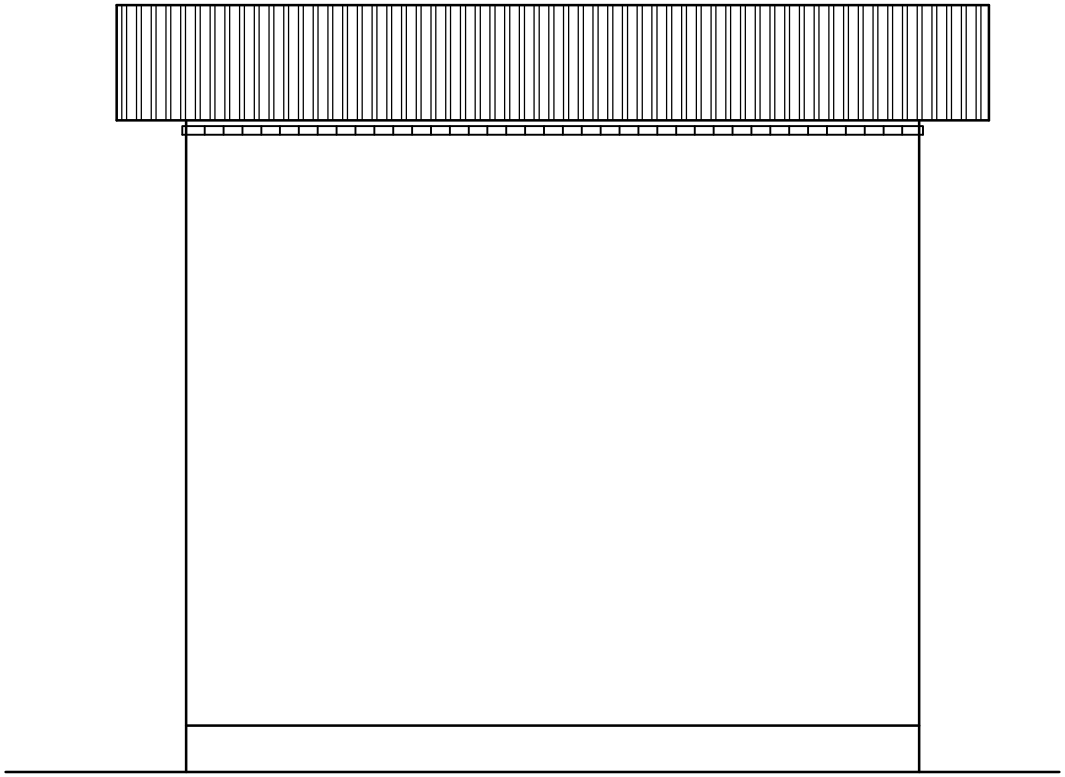
ROOF PLAN

Scale 1:100



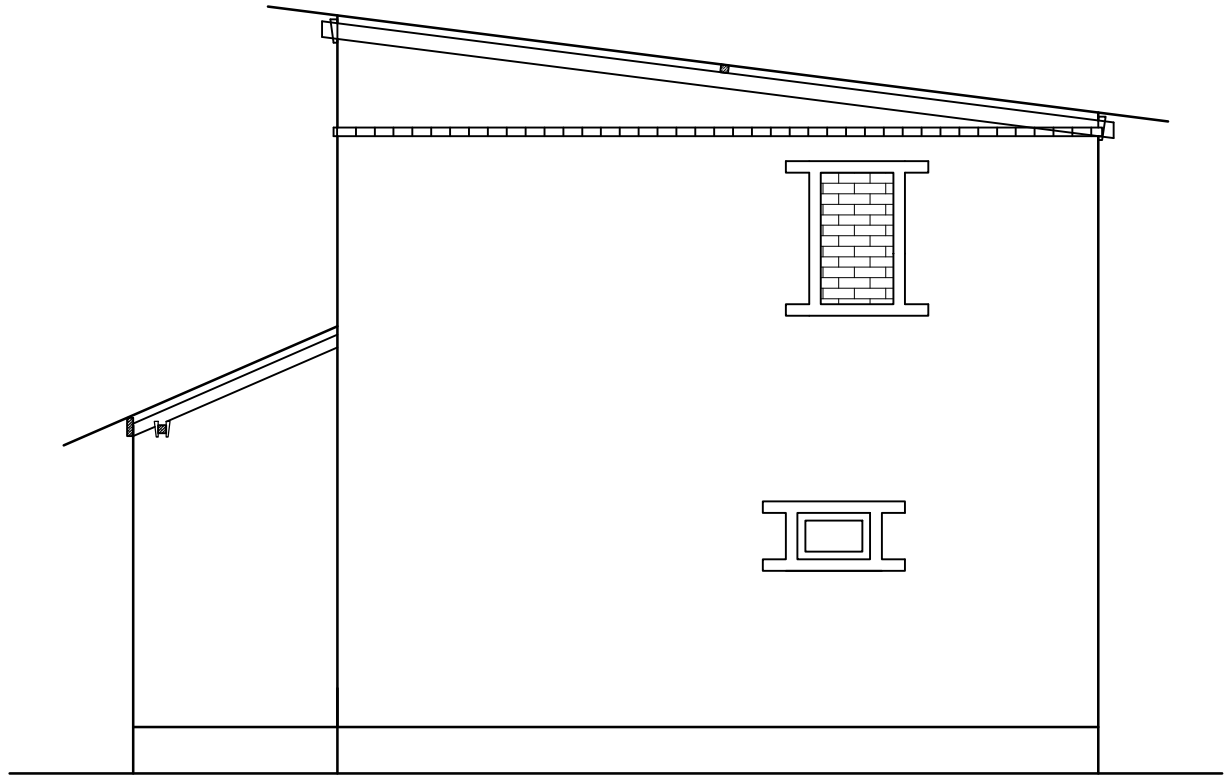
EAST ELEVATION

Scale 1:50



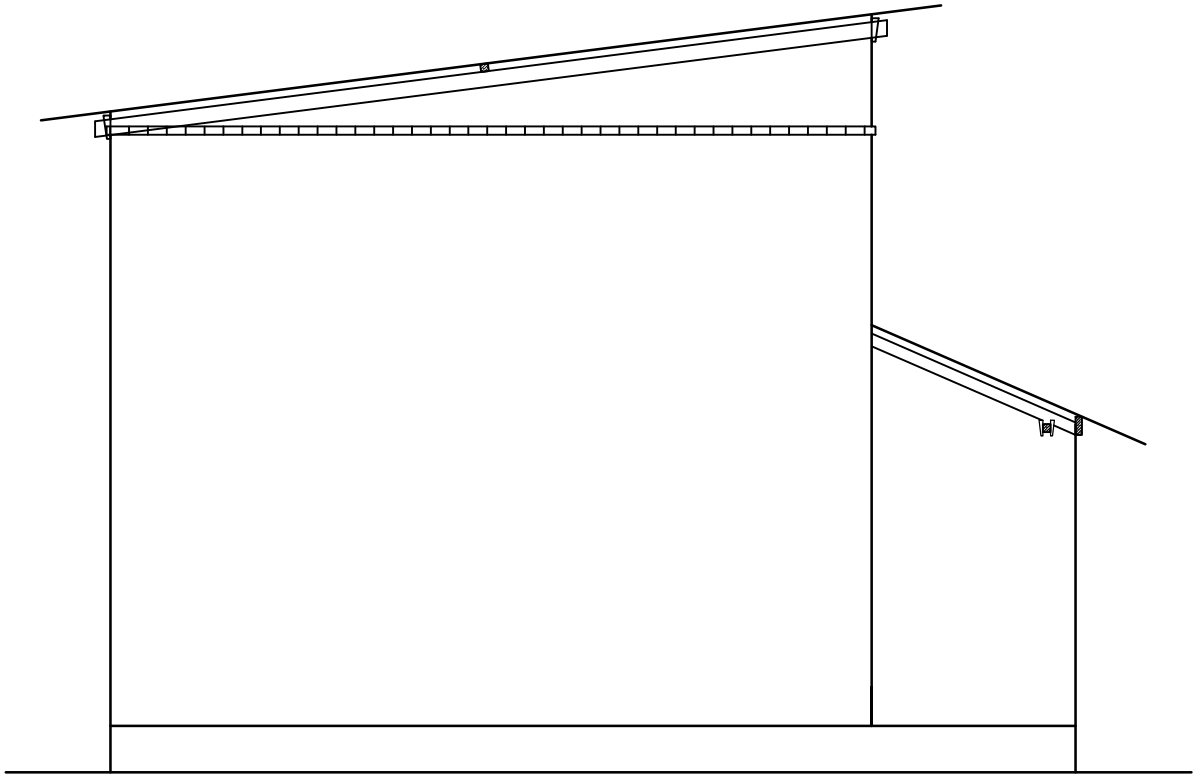
WEST ELEVATION

Scale 1:50



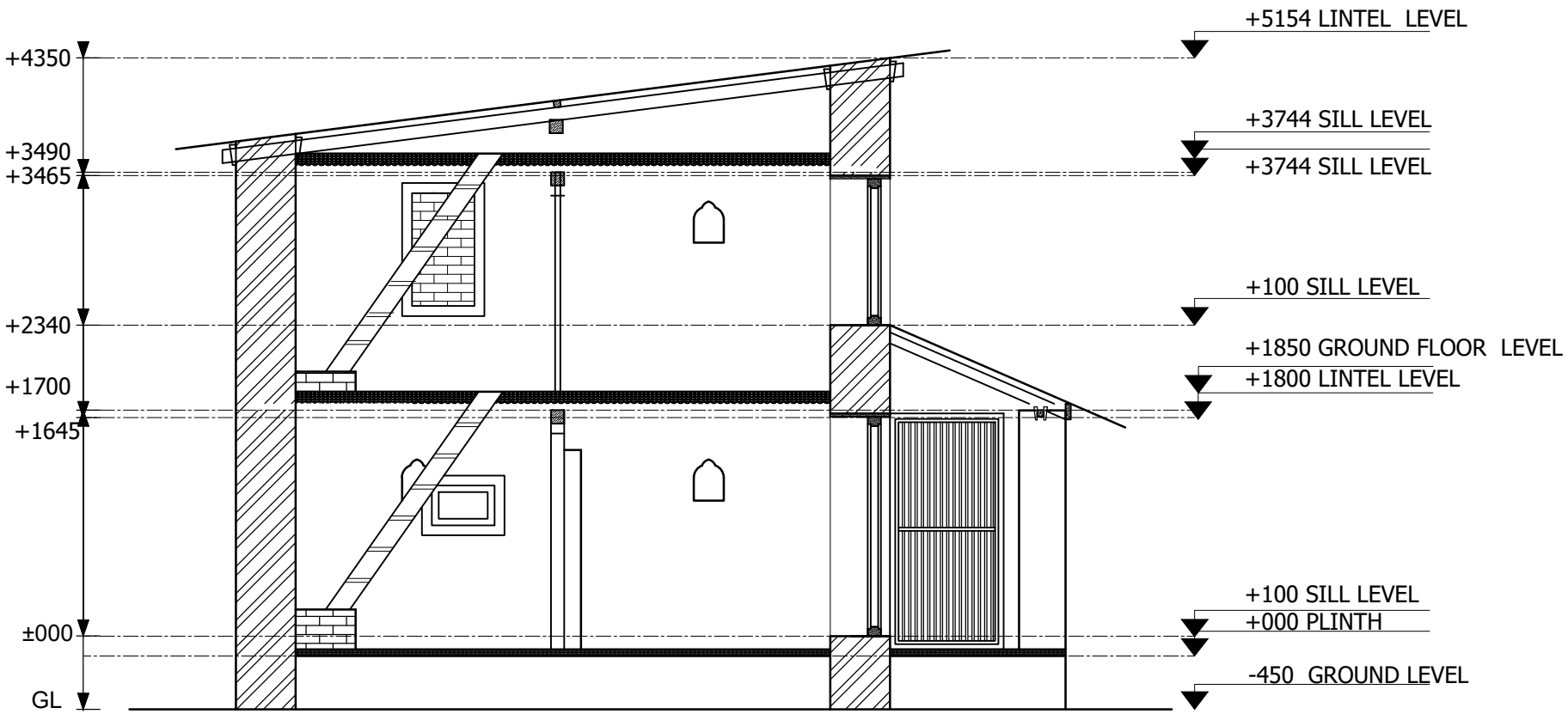
NORTH ELEVATION

Scale 1:50



SOUTH ELEVATION

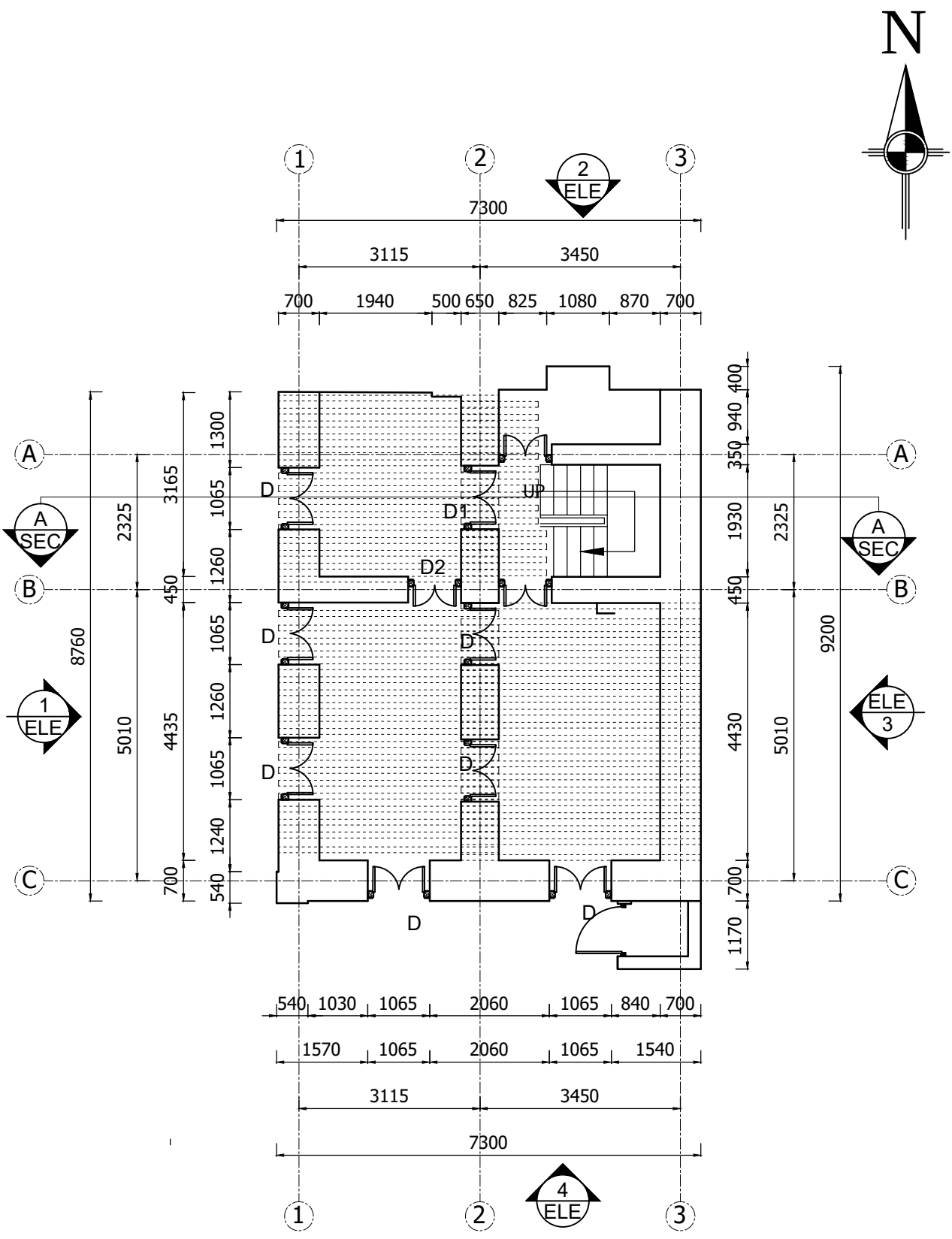
Scale 1:50



SECTION AT A-A

Scale 1:50

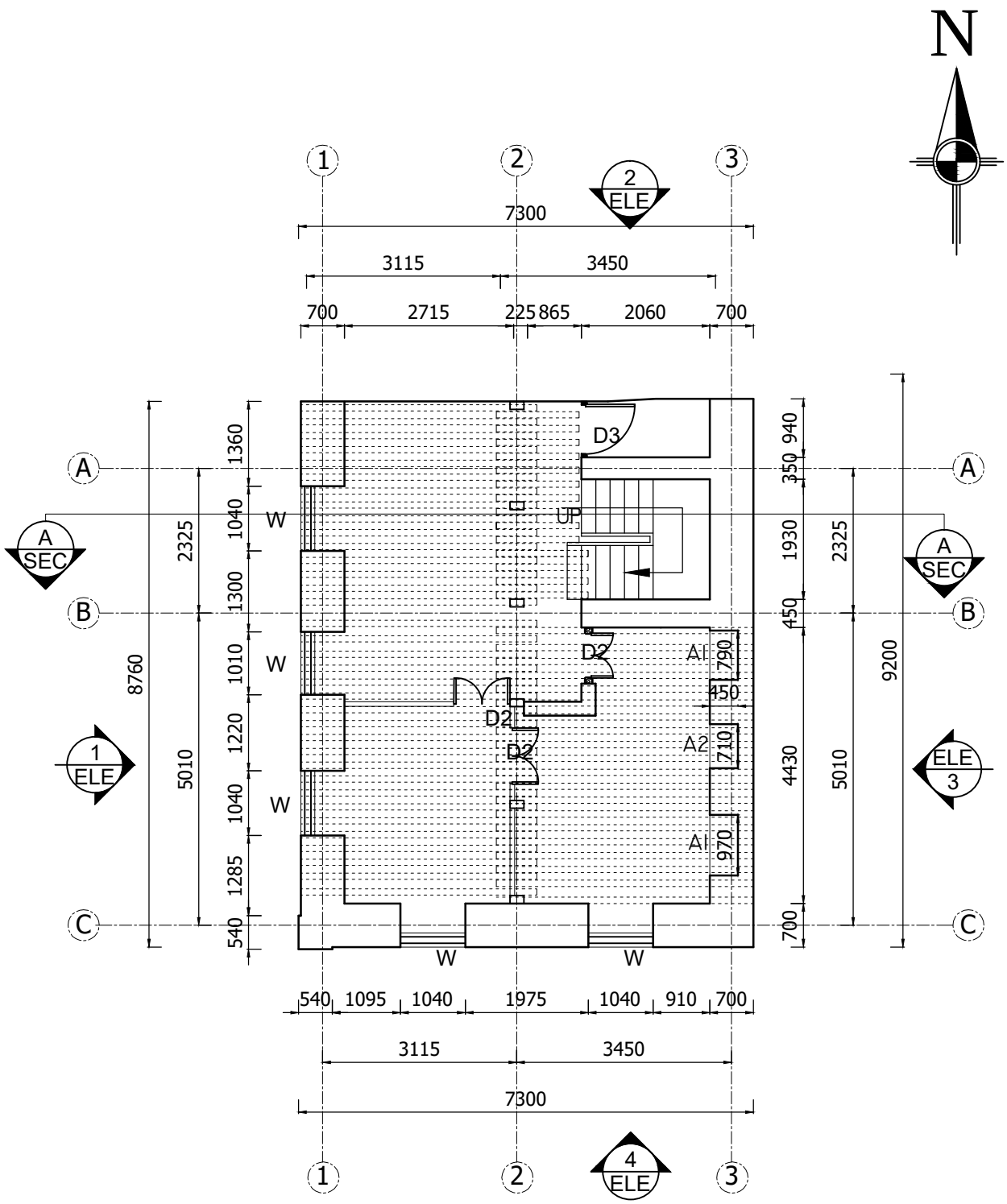
BRICK MASONRY
WITH
MUD MORTAR JOINT
AT
MARU TOLE,
KATHMANDU, NEPAL



GROUND FLOOR PLAN

PLINTH AREA = 63.82 sq.m.

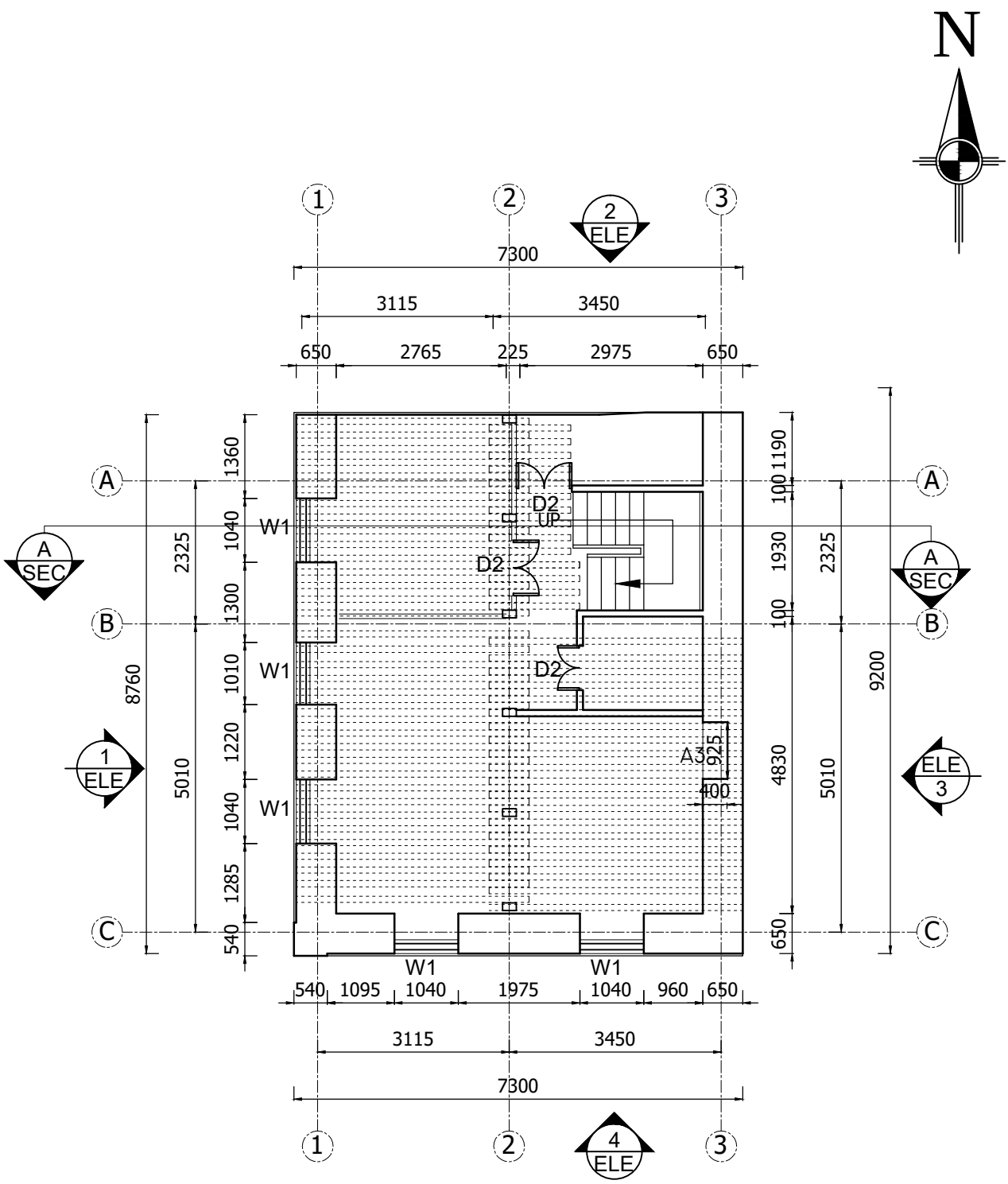
Scale 1:100



FIRST FLOOR PLAN

FLOOR AREA = 63.82 sq.m.

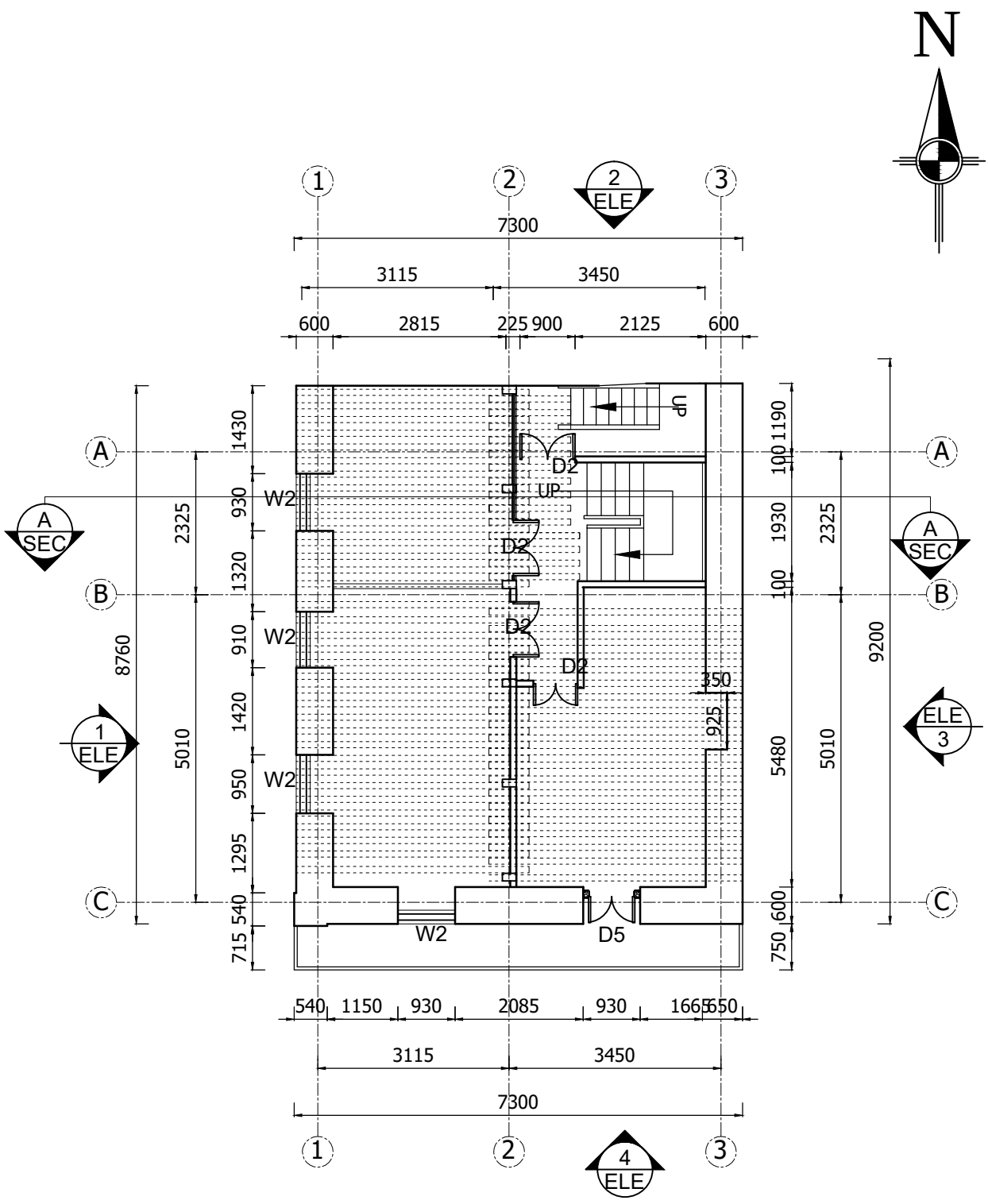
Scale 1:100



SECOND FLOOR PLAN

FLOOR AREA = 63.82 sq.m.

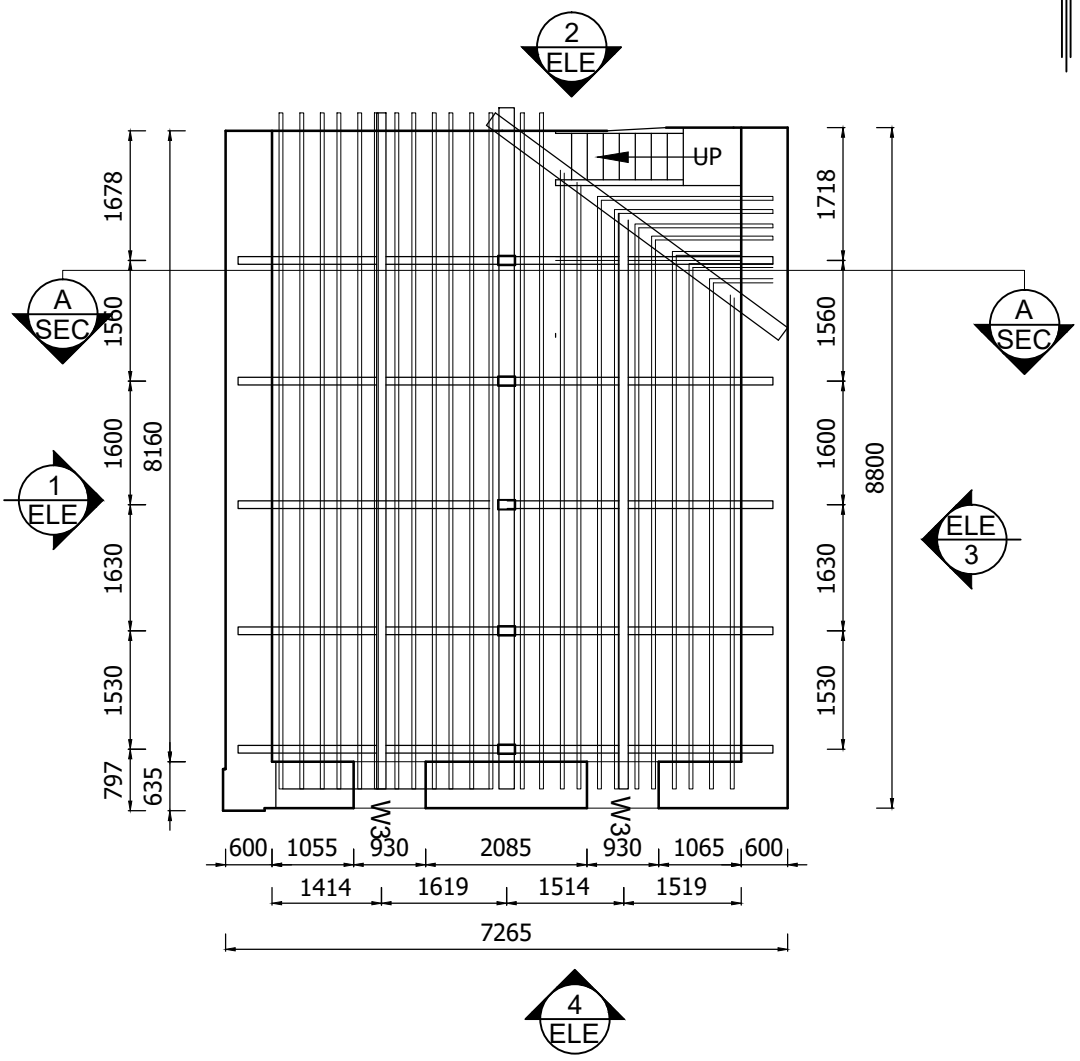
Scale 1:100



THIRD FLOOR PLAN

FLOOR AREA = 63.82 sq.m.

Scale 1:100



WOODEN TRUSS PLAN

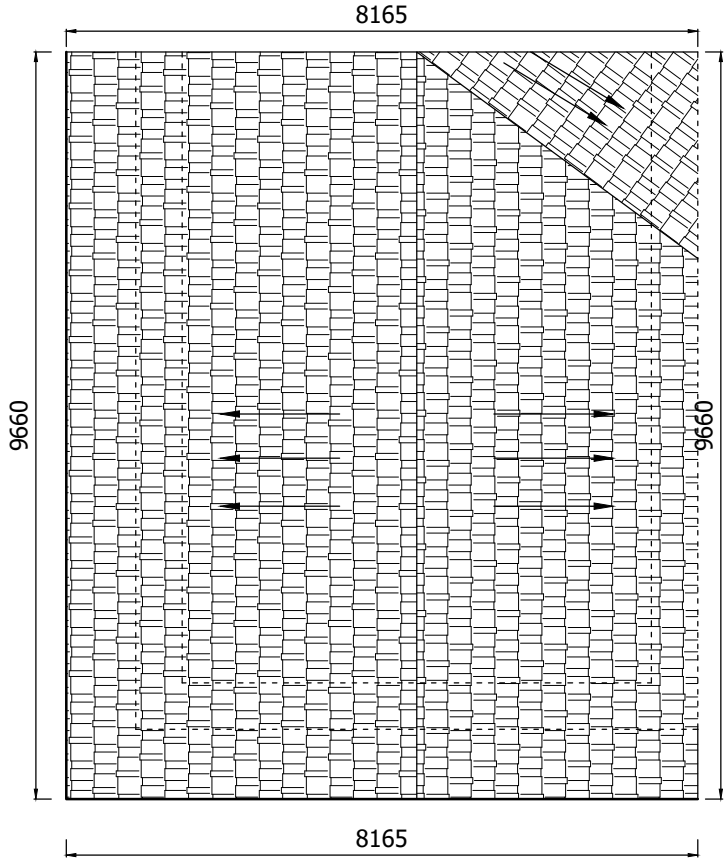
Scale 1:100

OPENING SHEDULE

NO.	DESCRIPTION	SYMBOL	SIZE	NOS.
1.	WINDOW	W	1040 X 1600	5
2.	WINDOW	W1	1010 X 1600	5
3.	WINDOW	W2	930 X 1600	4
4.	WINDOW	W3	930 X 930	2
5.	DOOR	D	1065 X 1860	7
5.	DOOR	D1	1090 X1830	1
6.	DOOR	D2	910 X 1760	11
7.	DOOR	D3	900 X 1720	1
8.	OPNING	W4	930 X 930	2

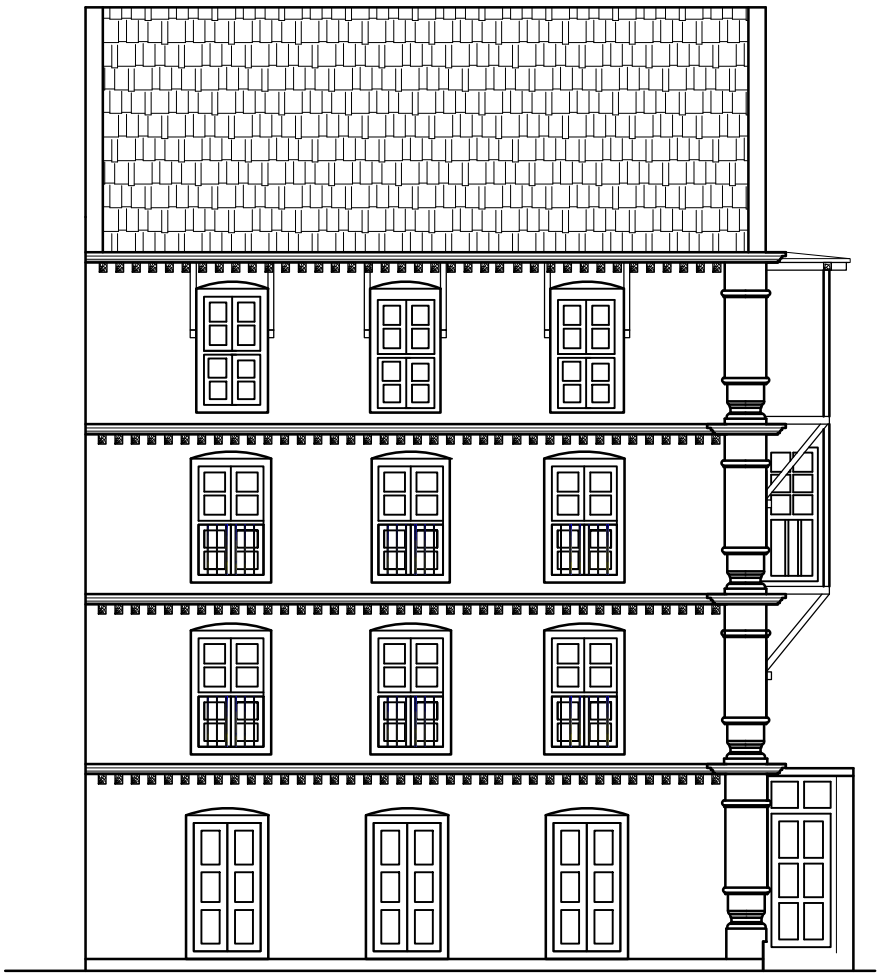
KHOPA IN WALL

NO.	DESCRIPTION	SYMBOL	SIZE	NOS.
1.	KHOPA	A1	450 X790 X 1620	2
2.	KHOPA	A2	450 X710X 1030	1
3.	KHOPA	A3	400 X925X 1020	1



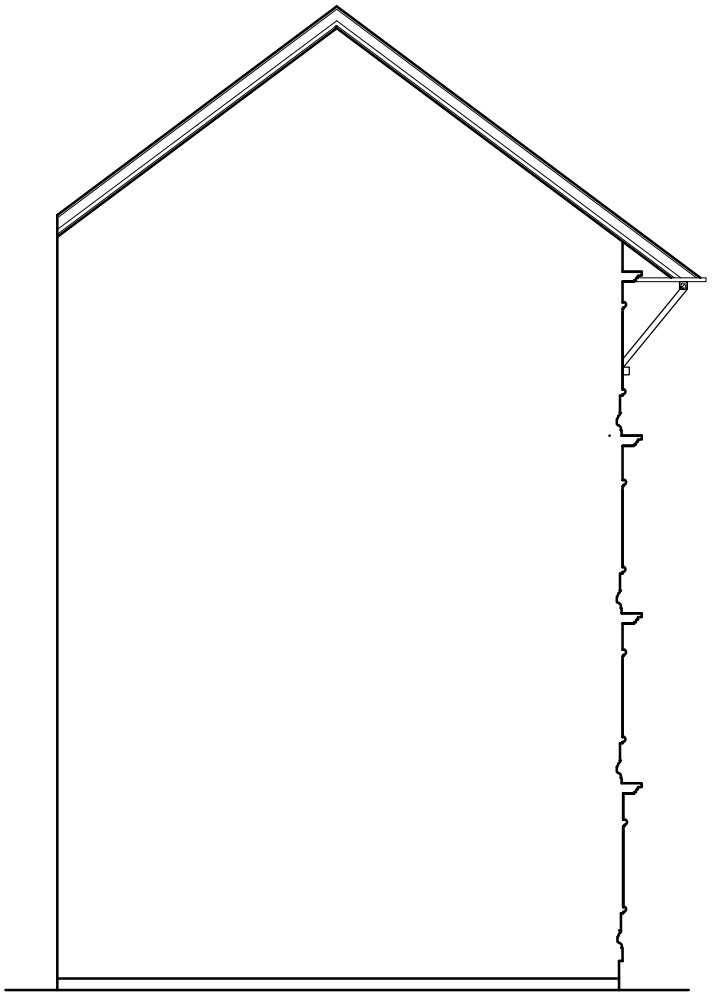
ROOF PLAN

Scale 1:100



ELEVATION 1

Scale 1:100

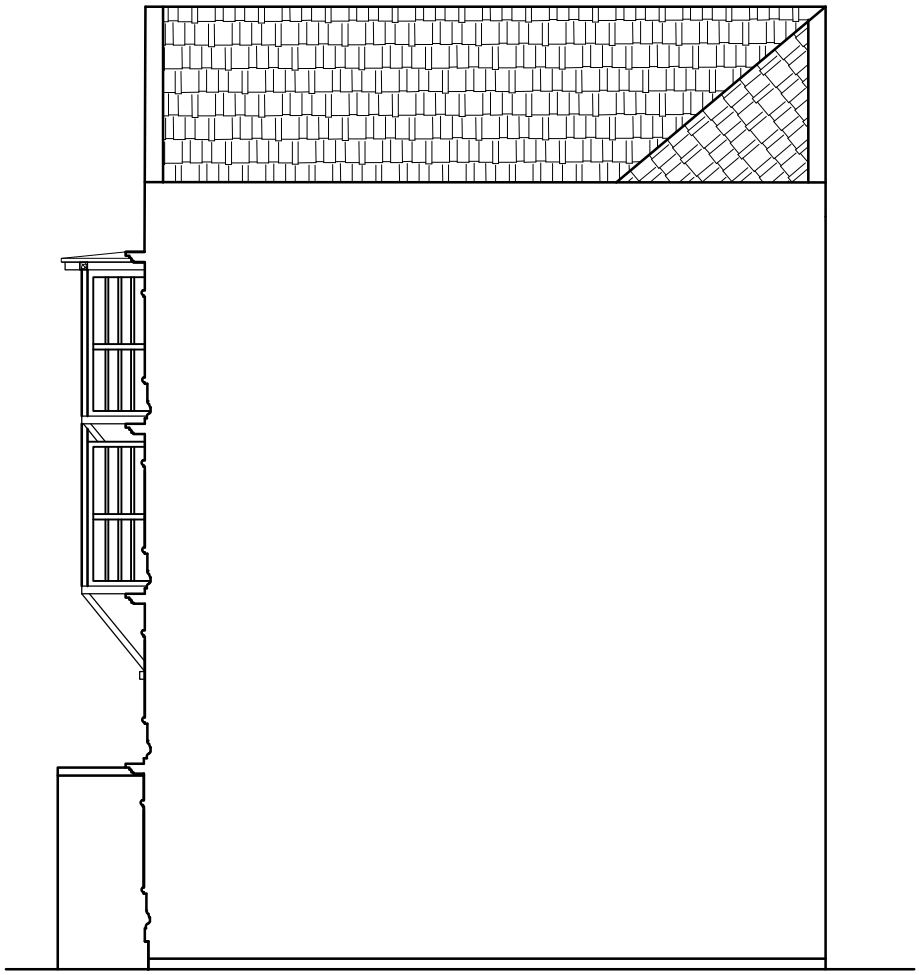


ELEVATION 2

Scale 1:100

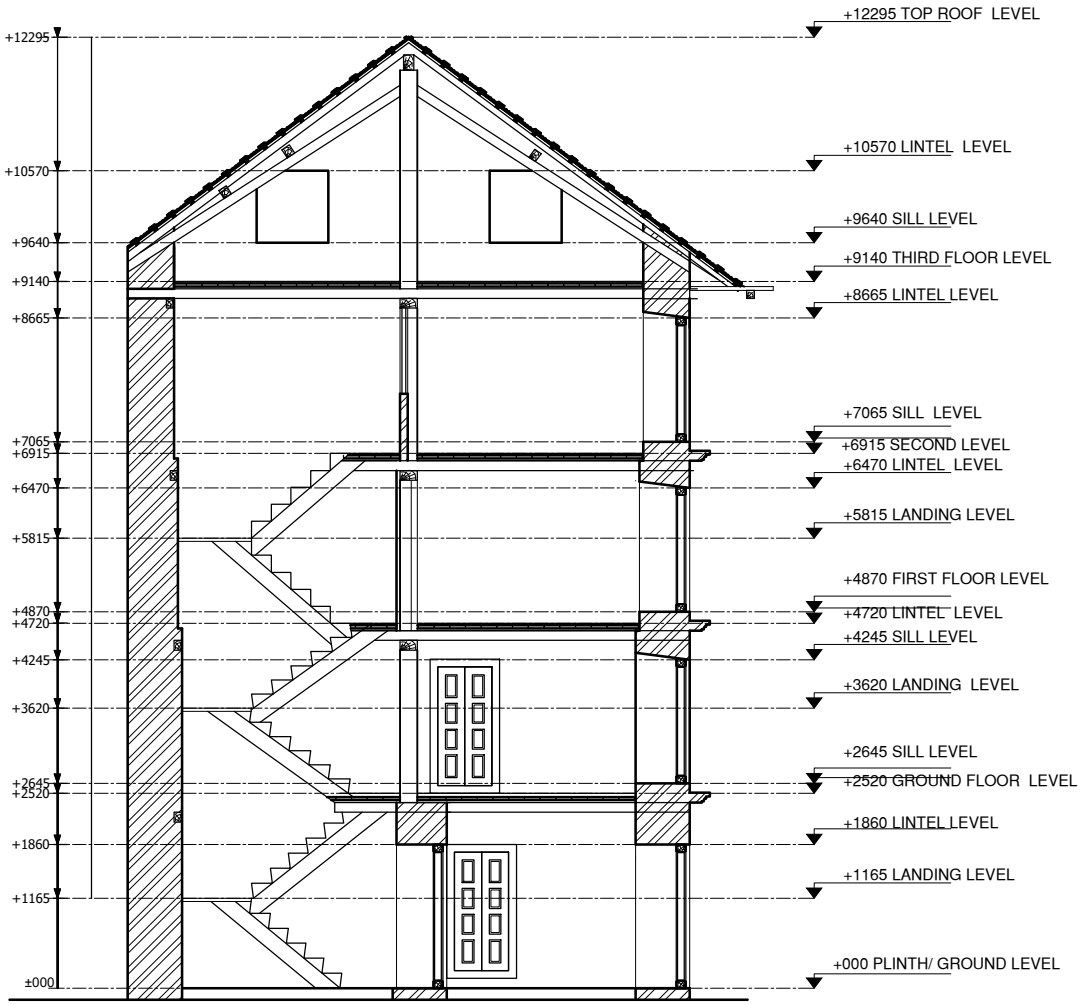
ELEVATION 3

Scale 1:100



ELEVATION 4

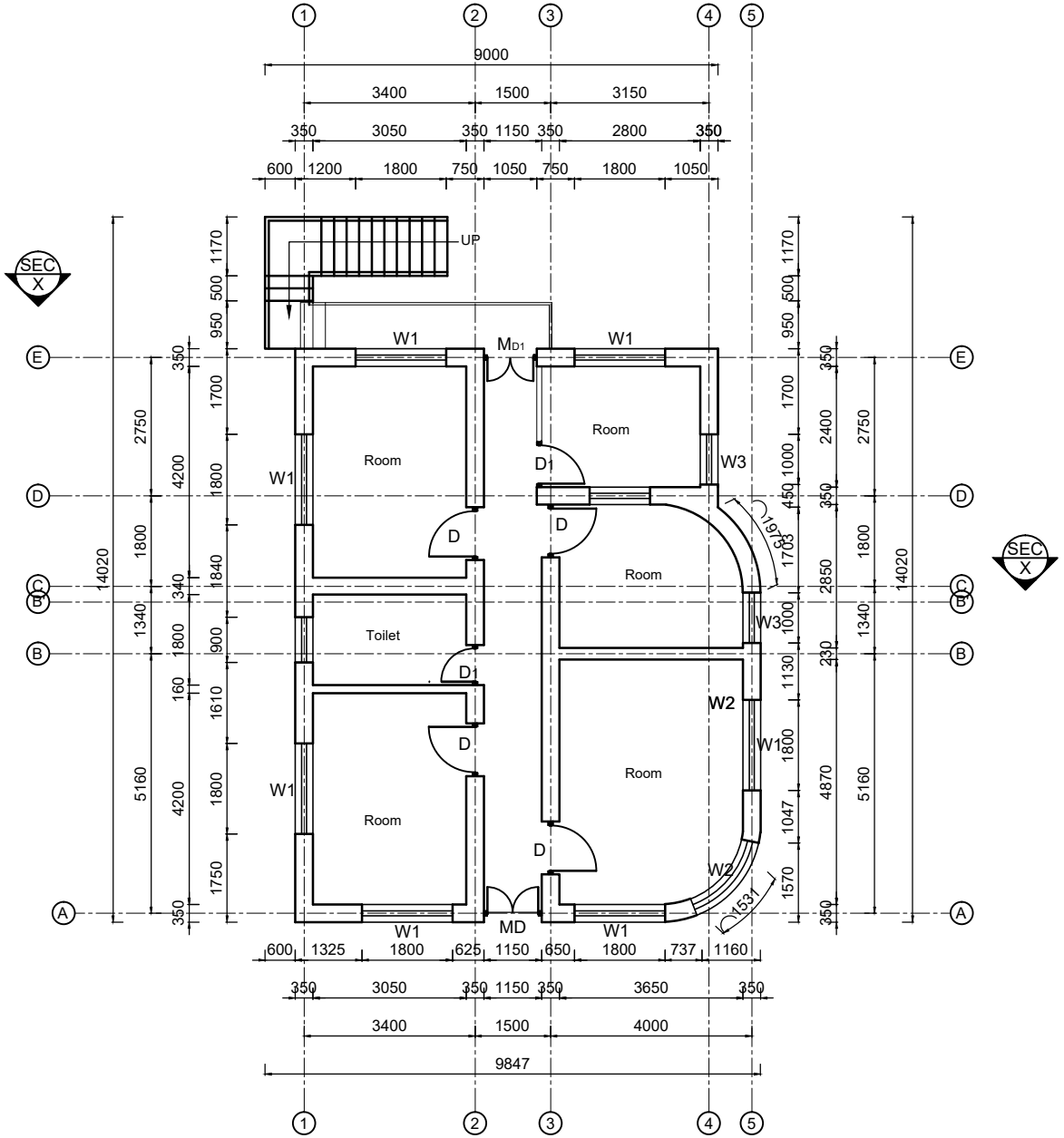
Scale 1:100



SECTION AT A-A

Scale 1:100

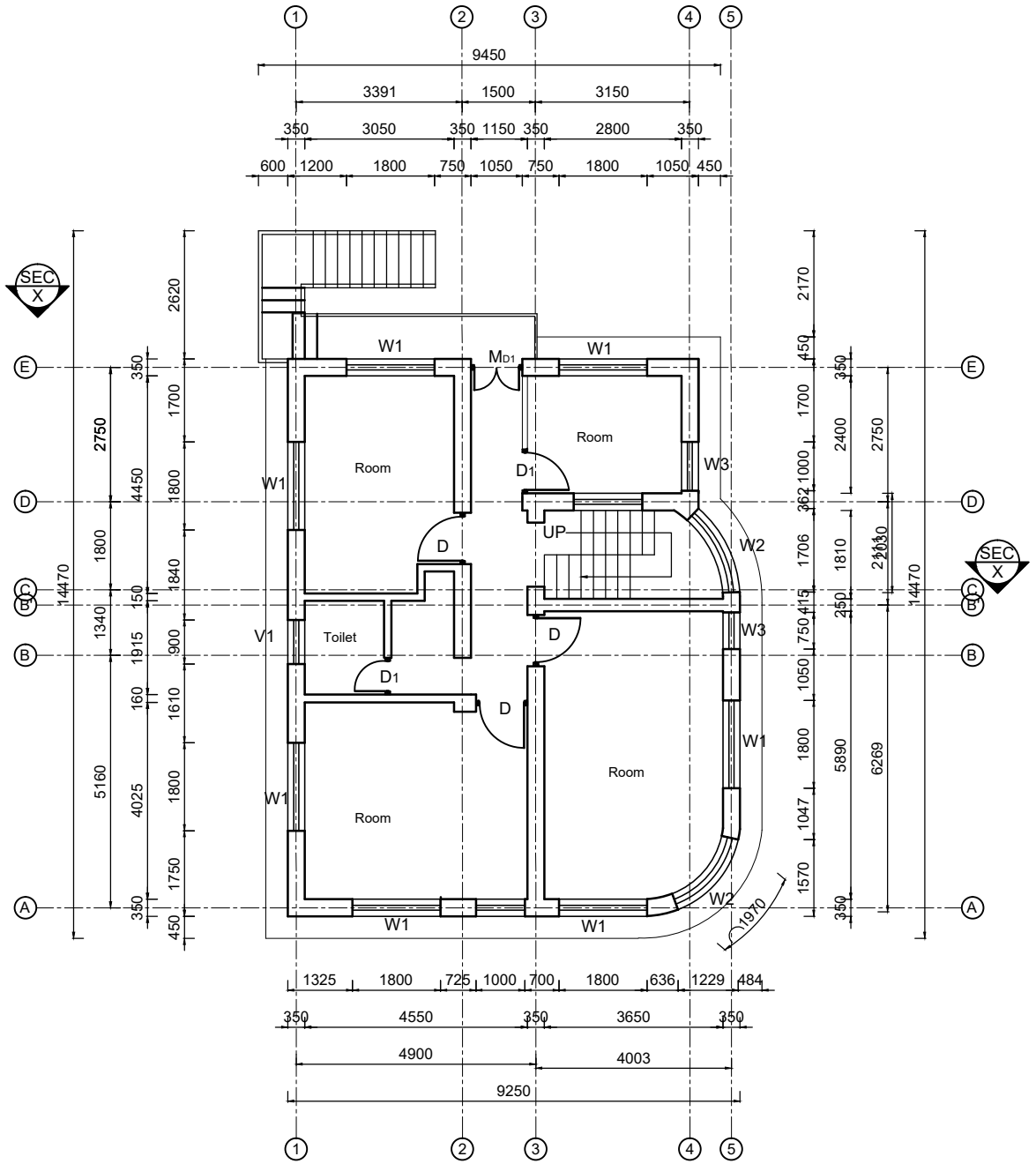
BRICK MASONRY
WITH
CEMENT MORTAR JOINT
AT BAKUNDOL,
LALITPUR, NEPAL



GROUND FLOOR PLAN

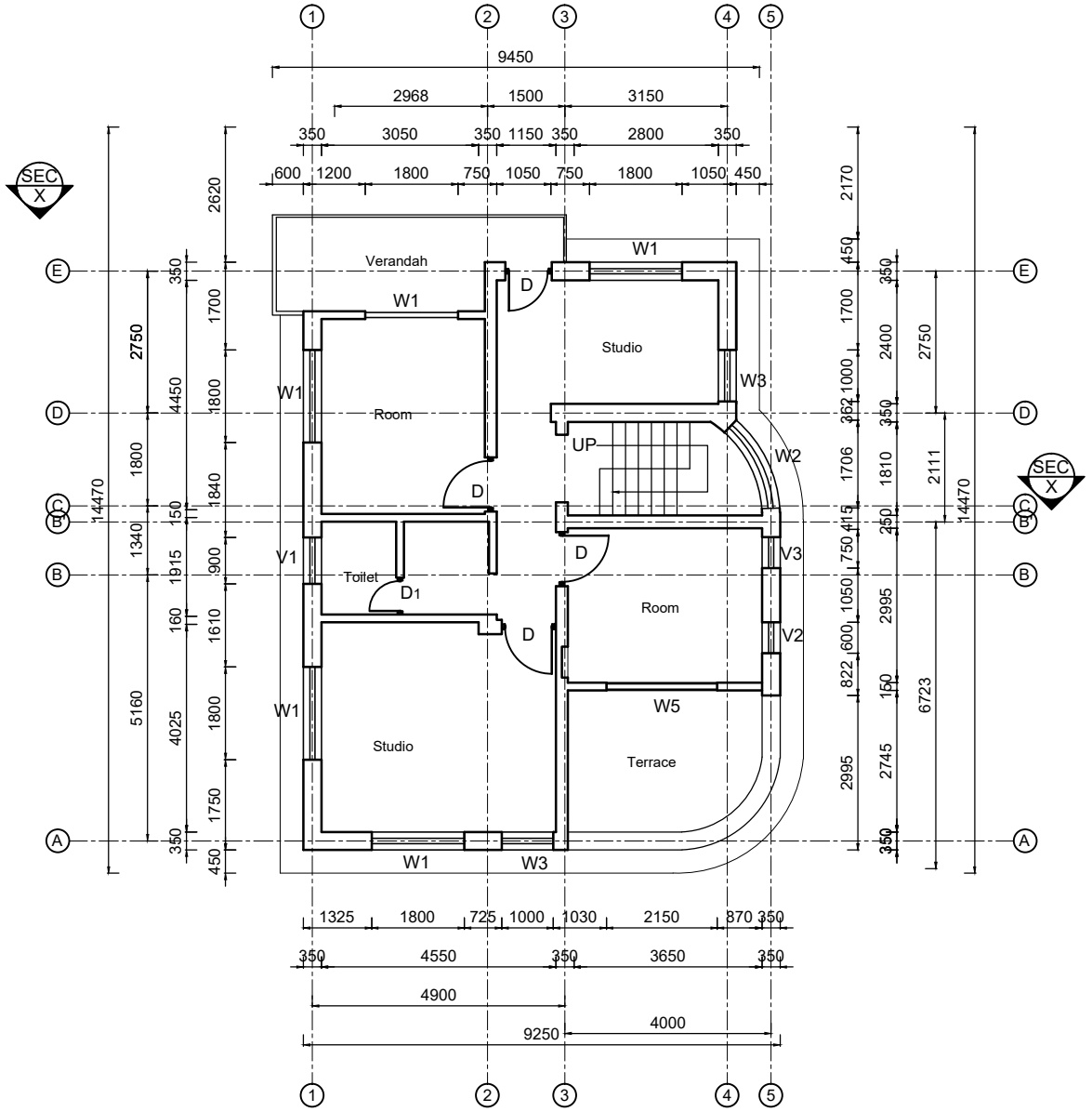
AREA = 111.00 sq.m.

Scale:100



FIRST FLOOR PLAN

AREA = 111.00 sq.m.



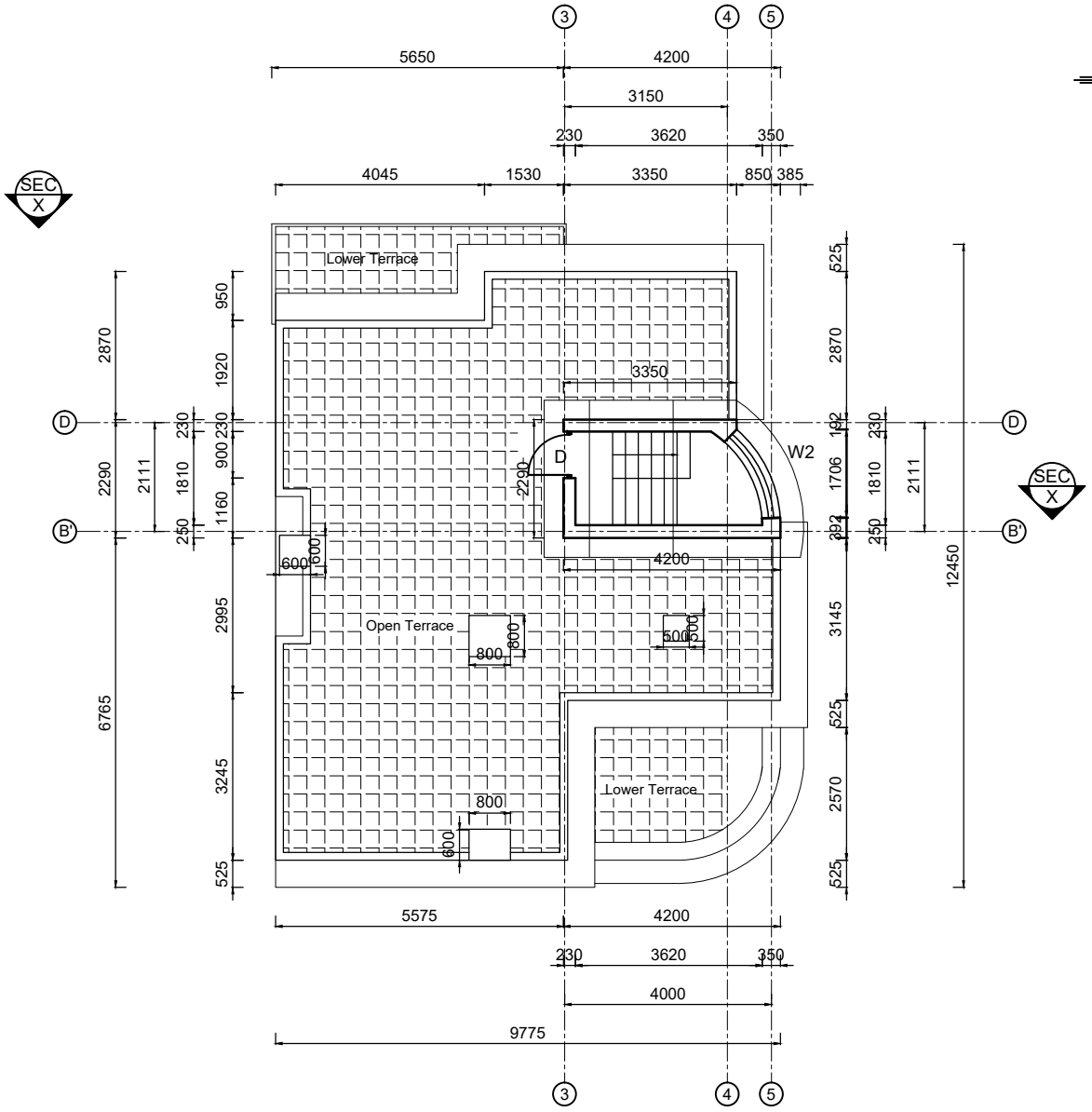
SECOND FLOOR PLAN

AREA = 104.70 sq.m.

Scale:100

OPENING SHEDULE

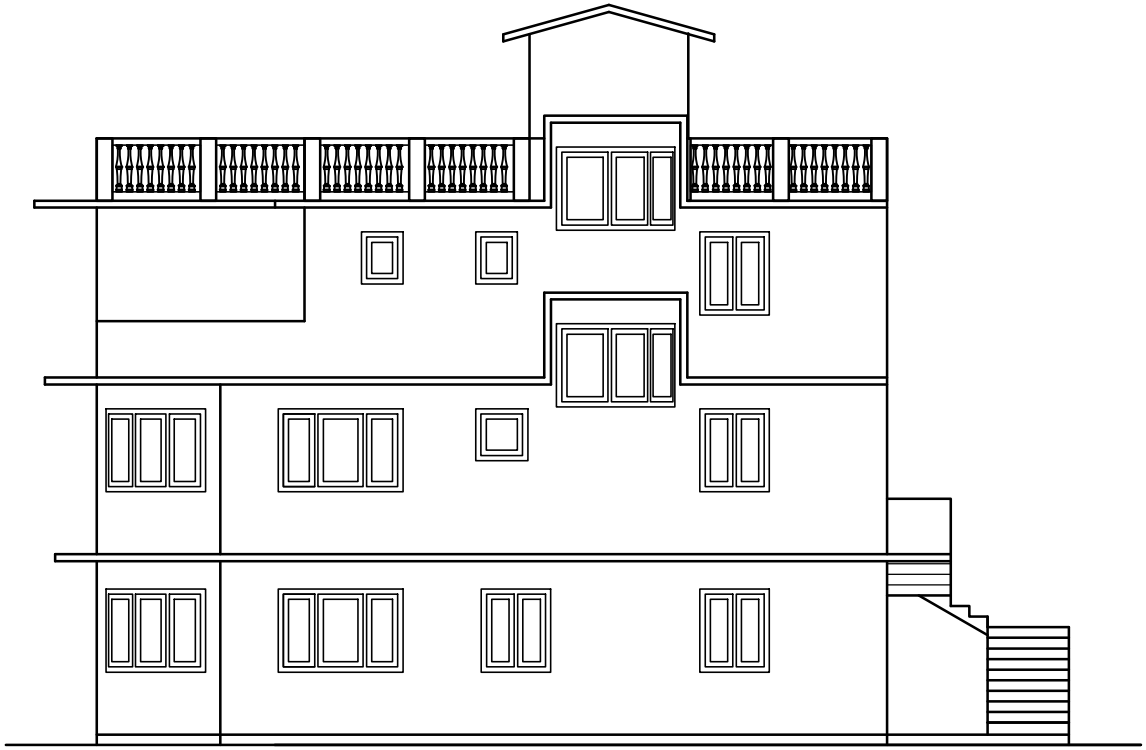
NO.	DESCRIPTION	SYMBOL	SIZE	NOS.
1.	WINDOW	W1	1800 X 1200 X 900	19
2.	WINDOW	W2	1970 X 1200 X 900	4
3.	WINDOW	W3	1000 X 1200 X 900	4
4.	WINDOW	W4	750 X 1200 X 900	1
5.	WINDOW	W5	2150 X 1200 X 900	1
6.	VENTILATION	V1	900 X 900 X 1200	1
7.	VENTILATION	V2	600 X 750 X 1350	1
8.	VENTILATION	V3	750 X 760 X 1350	1
9.	DOOR	MD	965 X 2160	1
10.	DOOR	MD1	800 X 2160	2
11.	DOOR	D1	965 X 2160	5
12.	DOOR	D2	800 X 2160	11



TOP FLOOR PLAN

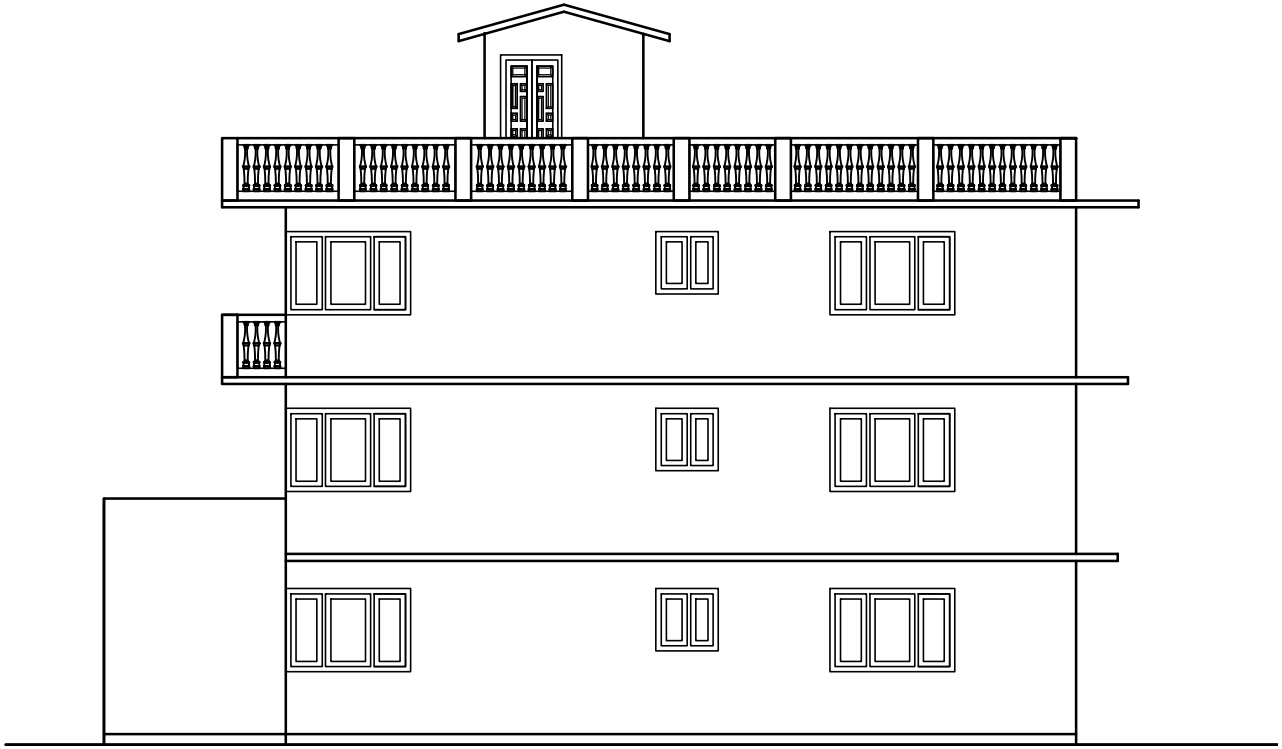
AREA = 104.70 sq.m.

Scale:100



EAST ELEVATION

Scale:100



WEST ELEVATION

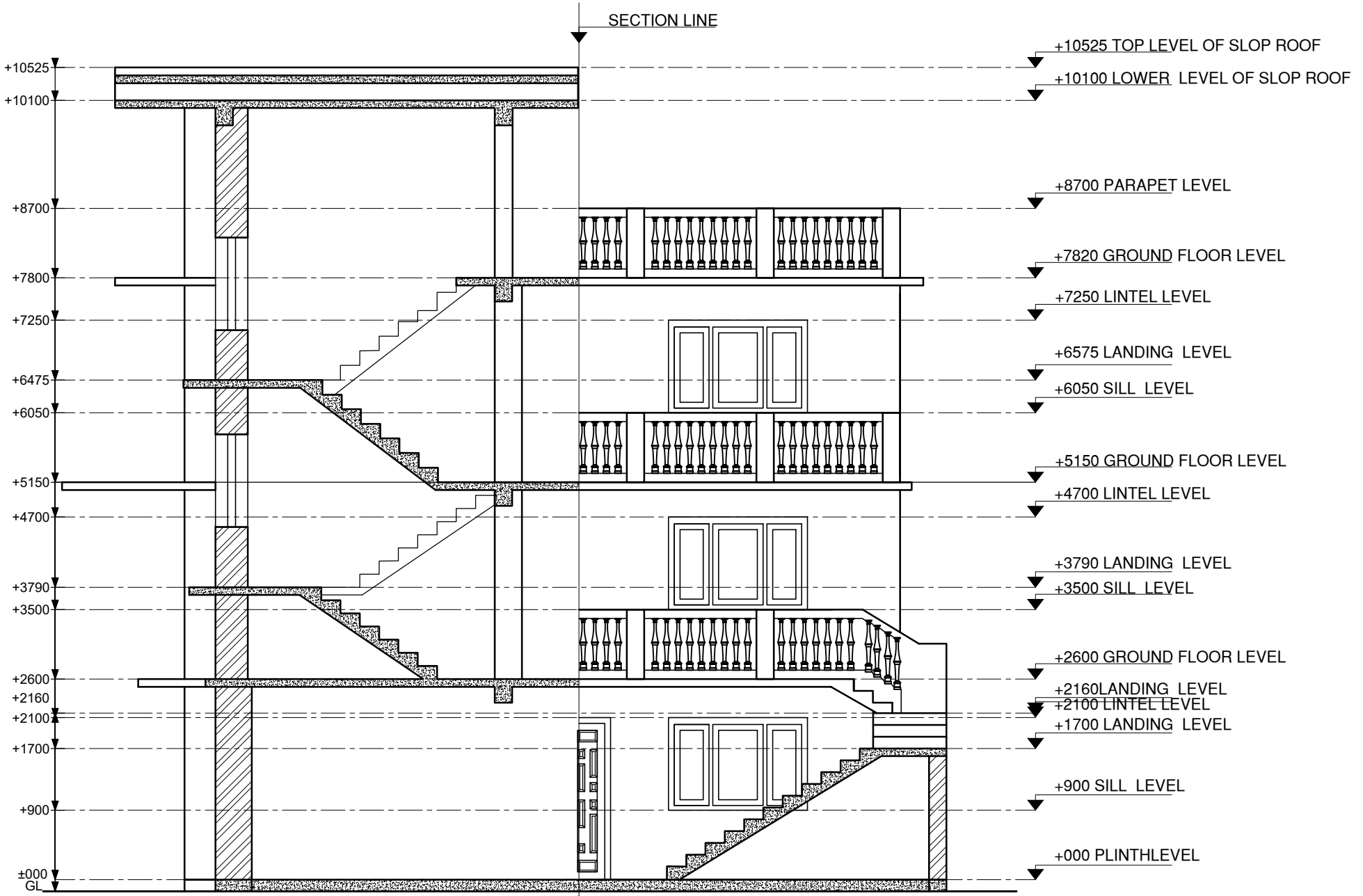
Scale:100

NORTH ELEVATION

Scale:100

SOUTH ELEVATION

Scale:100

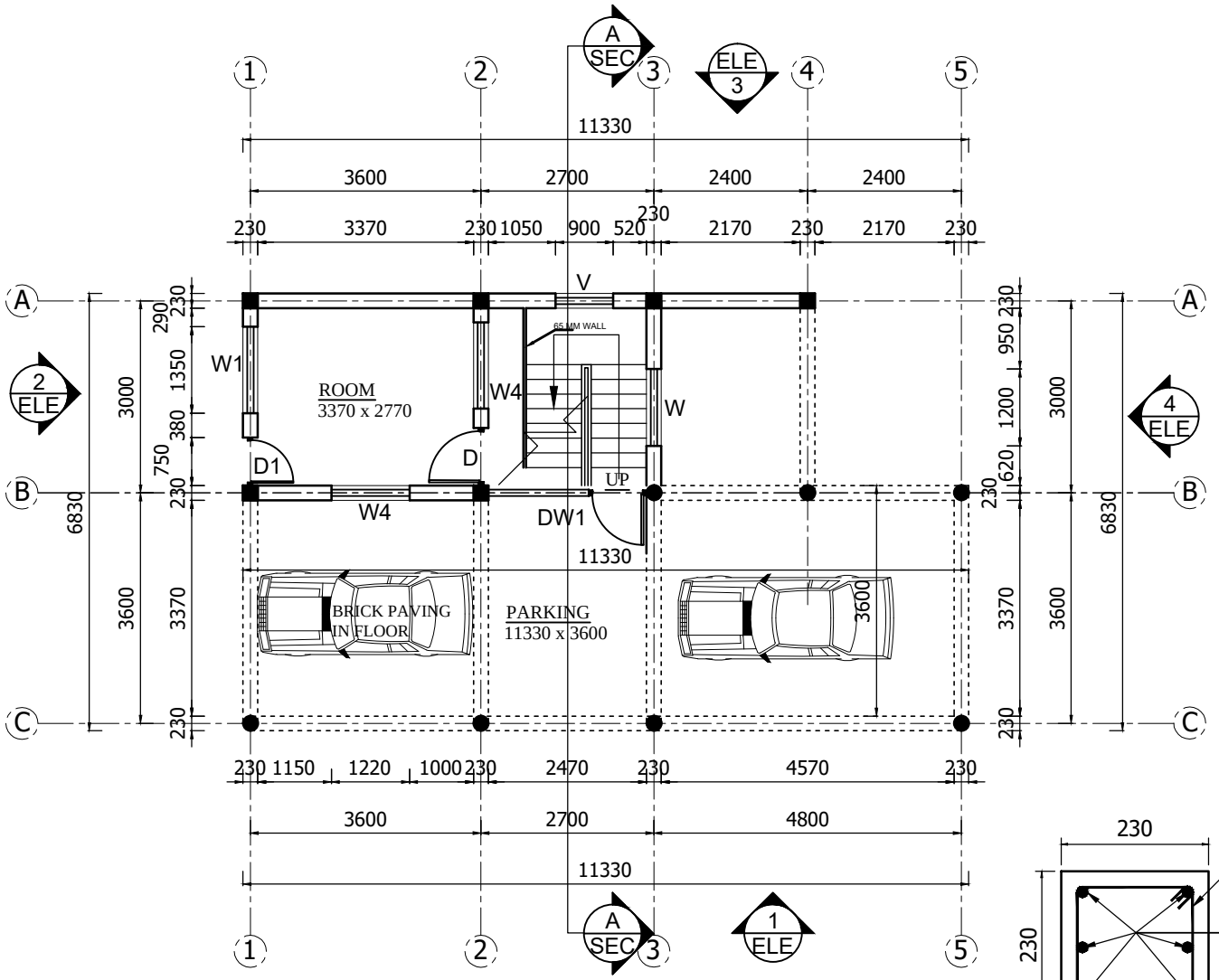


SECTION AT X-X

Scale:100

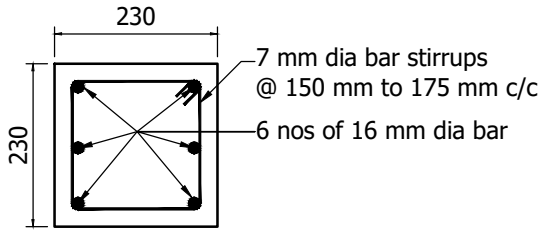
REINFORCED CONCRETE FRAME
WITH
SOFT STORY

AT CHUNDEVI, MAHARAJGUNJ
KATHMANDU, NEPAL

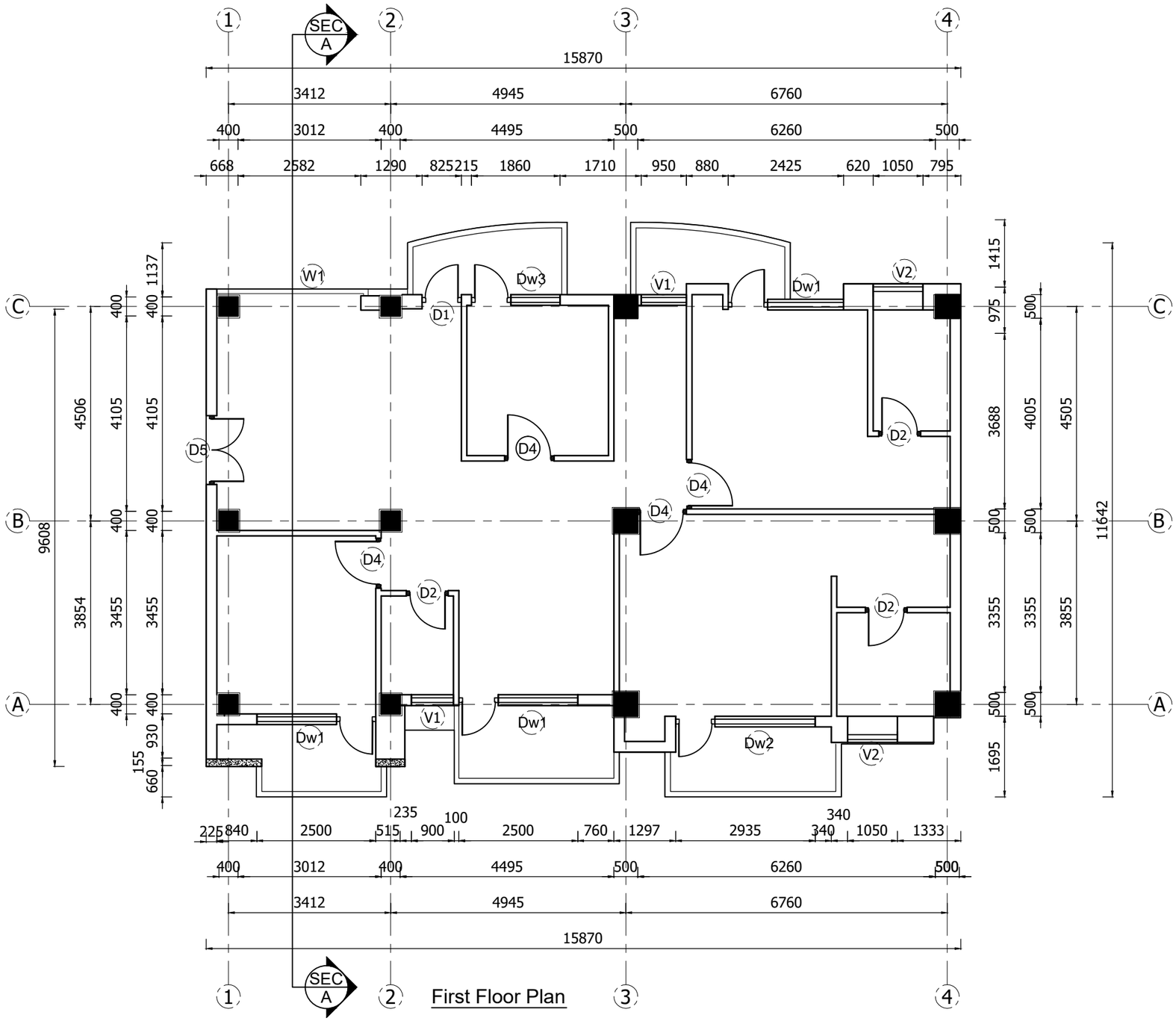


GROUND FLOOR PLAN

AREA = 70.18 sq.m.



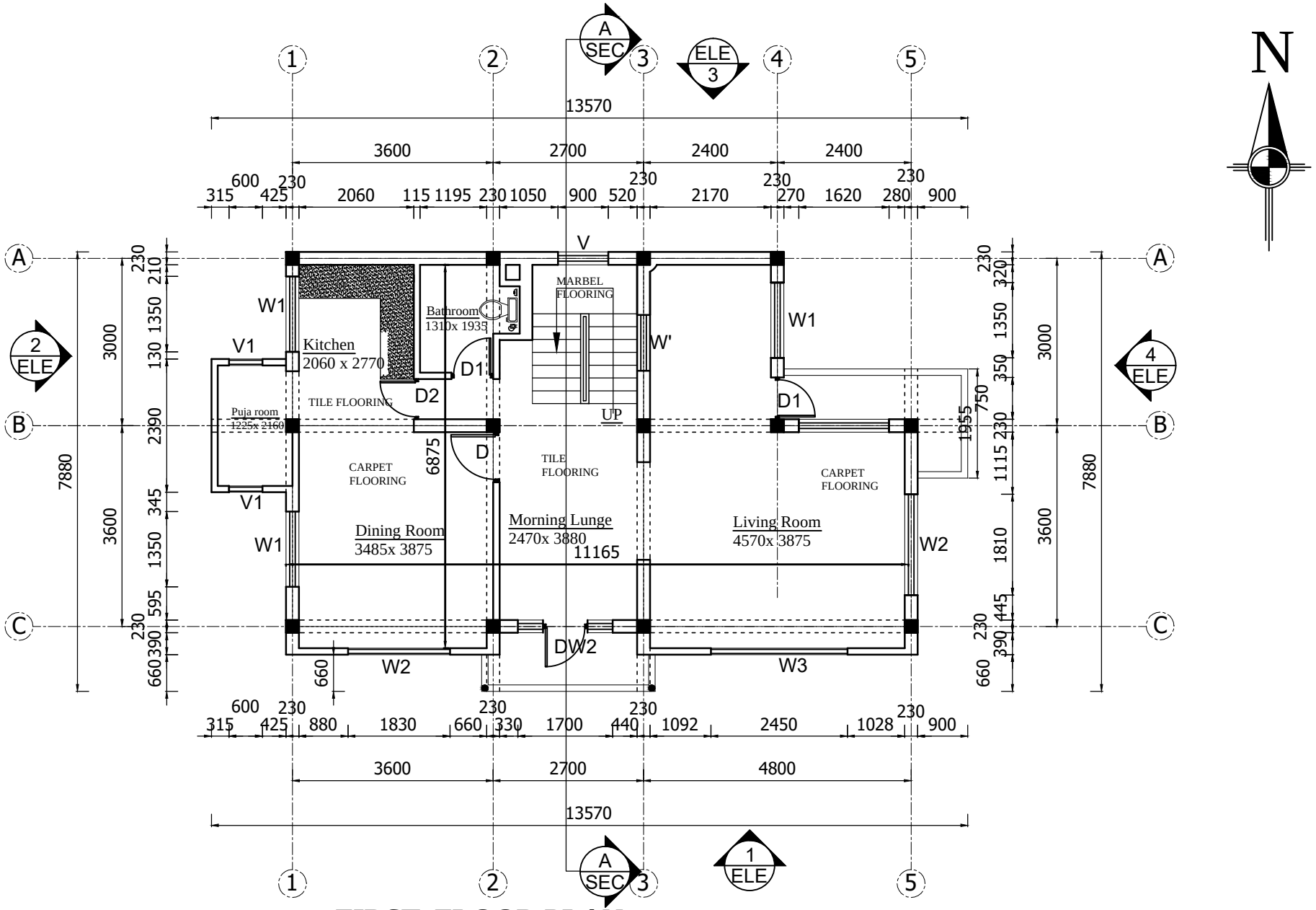
Typical Column Detail
Scale 1:10



First Floor Plan

Area = 170.277 sqm

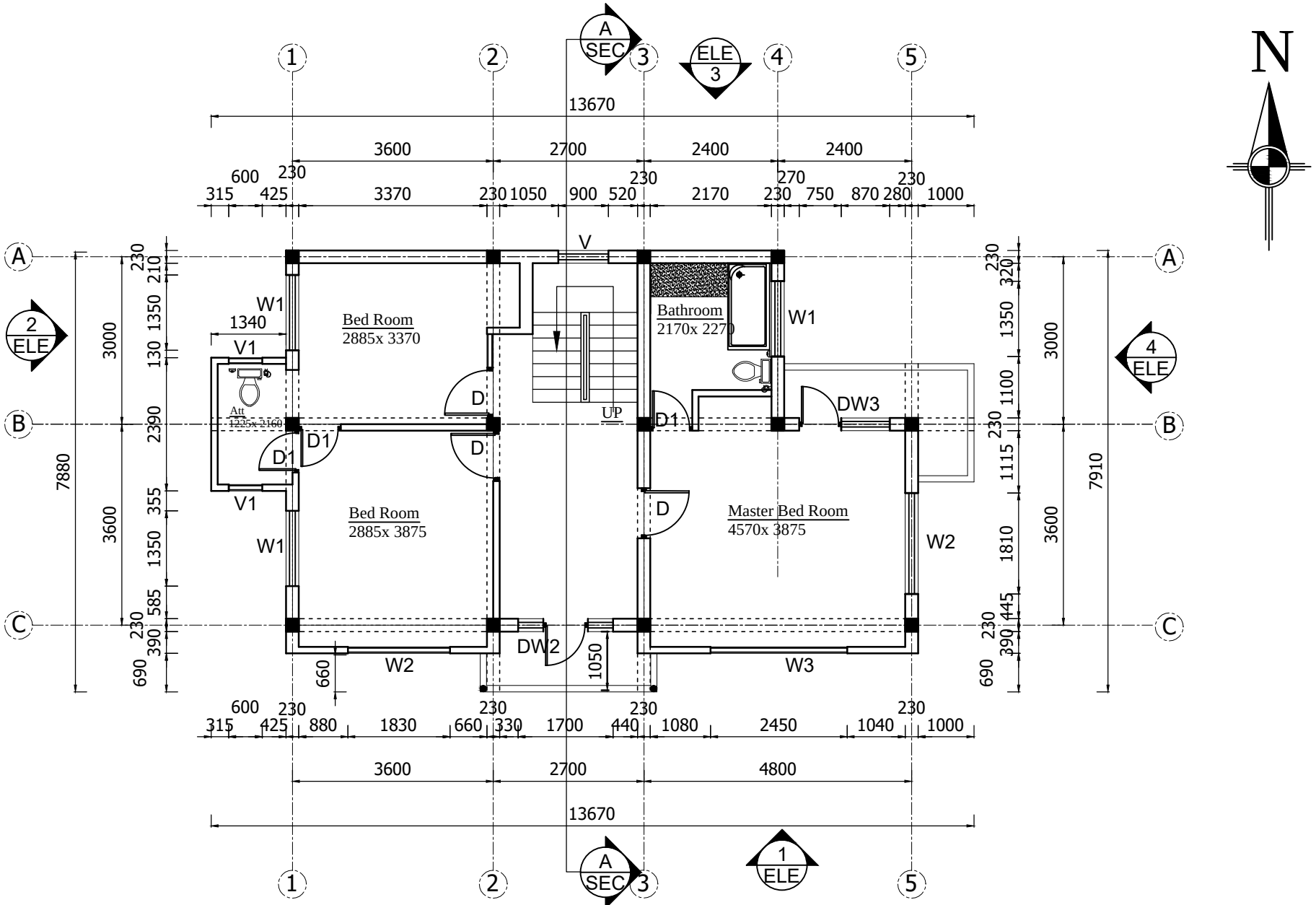
Floor height = 2688



FIRST FLOOR PLAN

FLOOR AREA = 83.78 sq.m.
including veranda

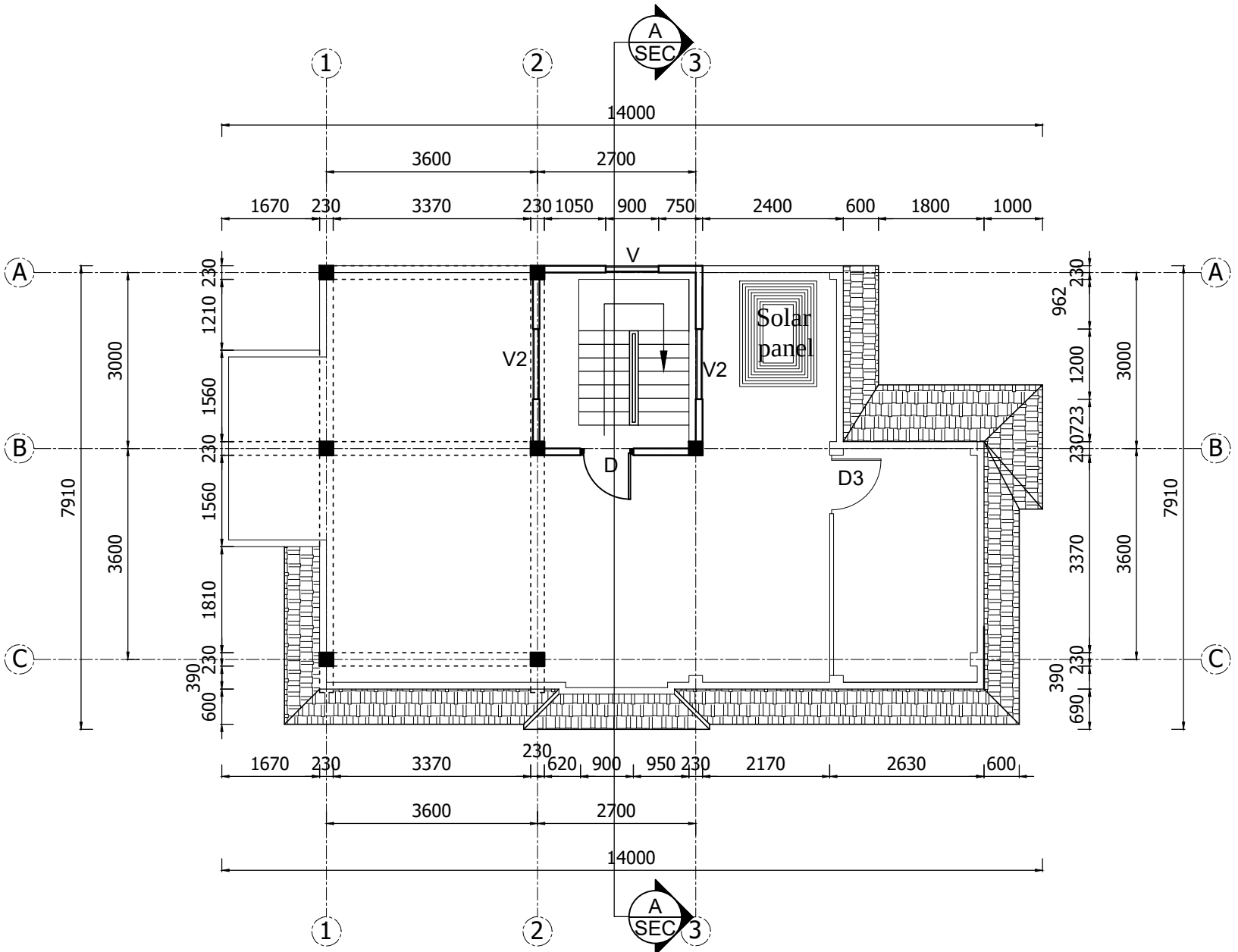
Scale 1:100



SECOND FLOOR PLAN

FLOOR AREA = 84.51 sq.m.
including veranda

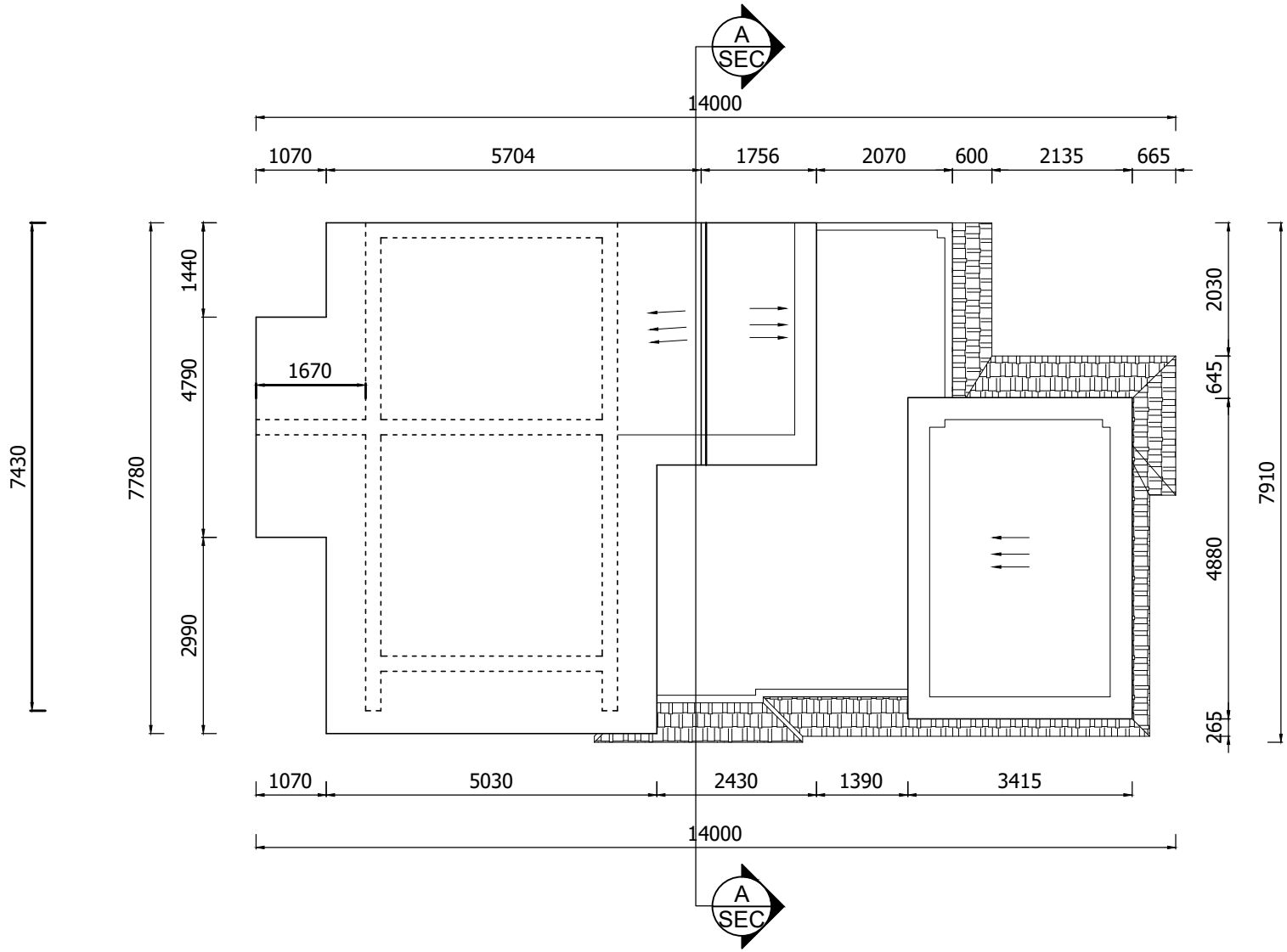
Scale 1:100



TOP FLOOR PLAN

FLOOR AREA = 42.07 sq.m.

Scale 1:100



ROOF PLAN

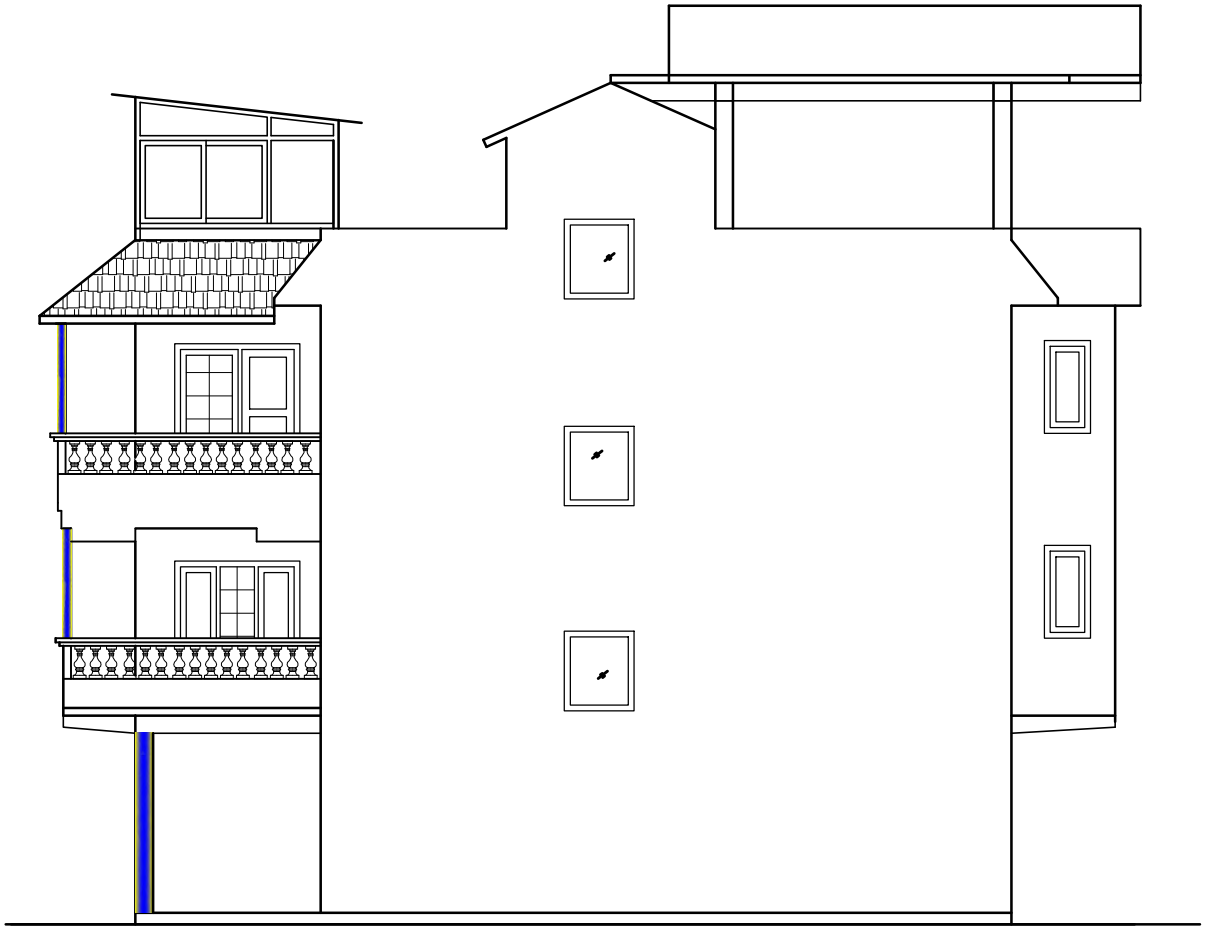
Scale 1:100

ELEVATION 1

Scale 1:100

ELEVATION 2

Scale 1:100

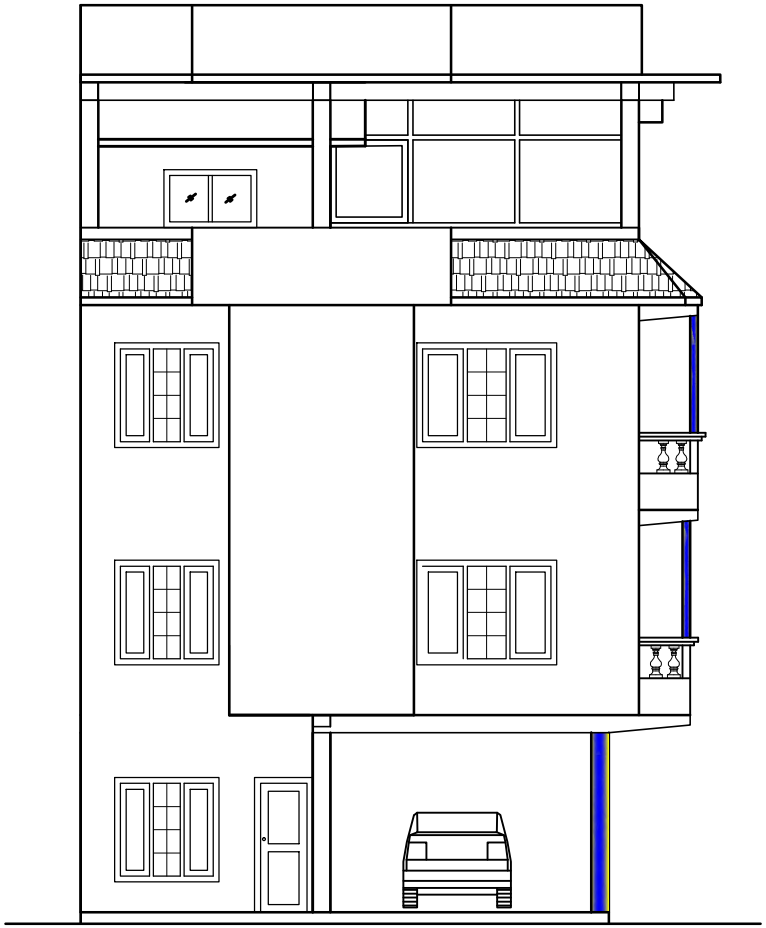


ELEVATION 3

Scale 1:100

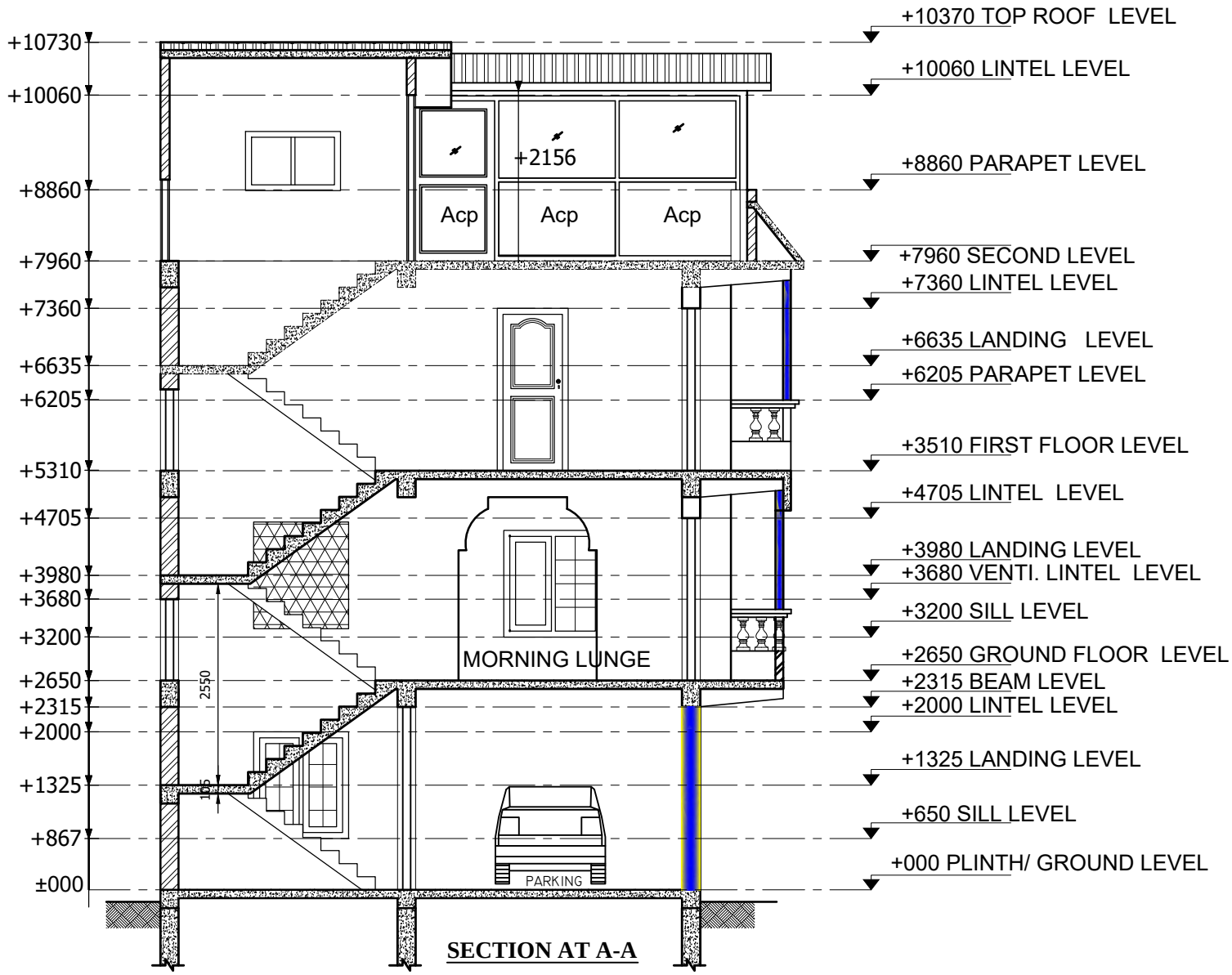
OPENING SHEDULE

NO.	DESCRIPTION	SYMBOL	SIZE	NOS.
1.	WINDOW	W	1200 X 1200	1
2.	WINDOW(TICKI JHYAL)	W'	1200 X 1200	1
3.	WINDOW	W1	1350 X 1350	1
4.	WINDOW	W2	1830 X 1350	4
5.	WINDOW	W3	2450 X 1350	1
5.	WINDOW	W4	1200 X 1350	2
6.	VENTILATION	V	900 X 900	4
7.	VENTILATION	V1	600 X 1200	1
8.	VENTILATION	V2	1200 X 750	1
9.	DOOR	D	900 X 2100	6
10.	DOOR	D1	750 X2100	1
11.	DOOR	D2	700 X 2100	1
12.	DOOR	D3	1000 X 2100	4
13.	DOOR WITH WINDOW	DW1	1550 X 2500	1
			900 X 2100	1
14.	DOOR WITH WINDOW	DW2	450 X 1350	4
			800 X 1350	2
15.	DOOR WITH WINDOW	DW3	750 X 1350	1
			870 X 1350	1



ELEVATION 4

Scale 1:100



SECTION AT A-A

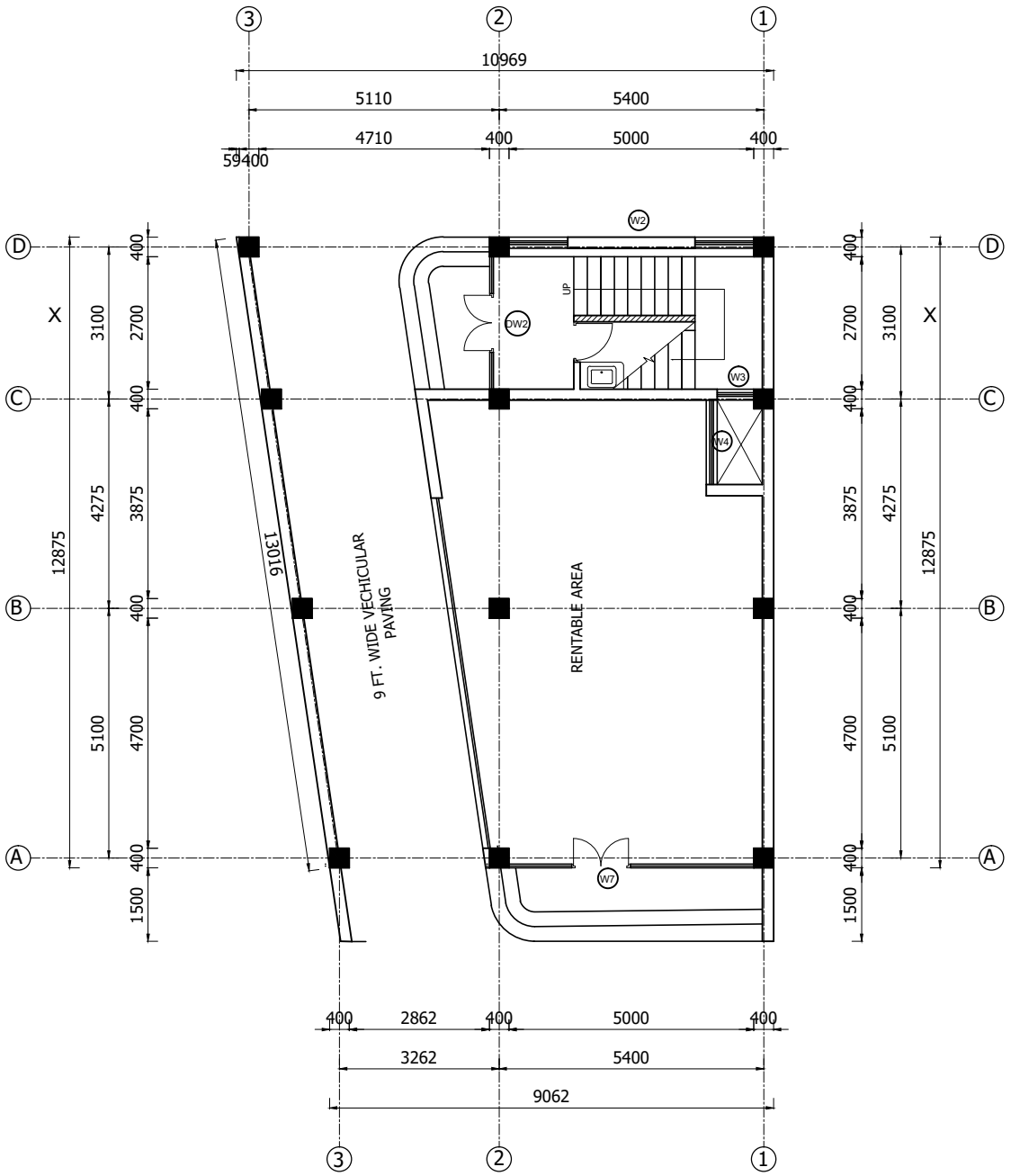
Scale 1:80

REINFORCED CONCRETE FRAME

BY

ENGINEERED CONSTRUCTION

AT SAMAKHUSI,
KATHMANDU, NEPAL

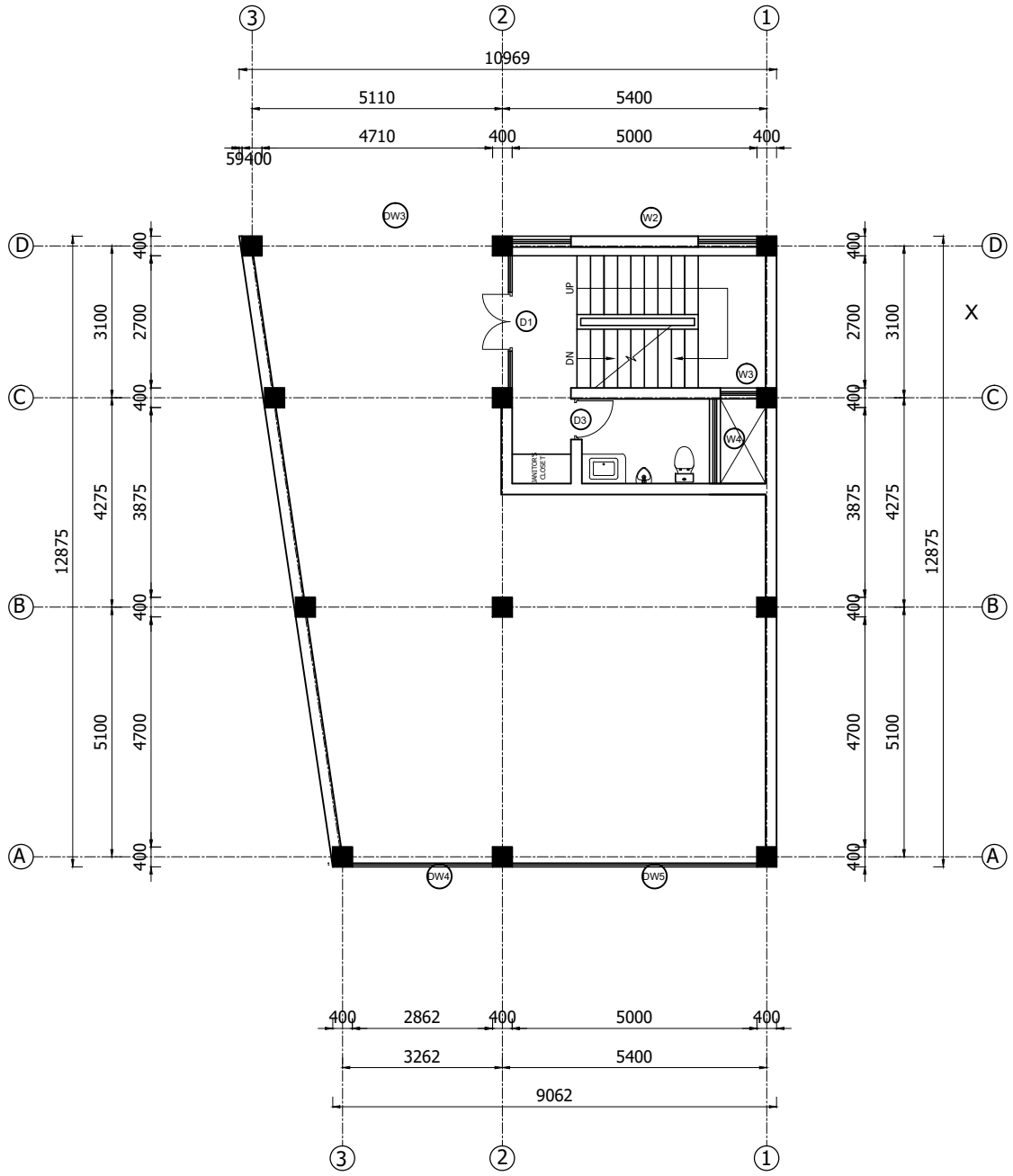


N

GROUND FLOOR PLAN

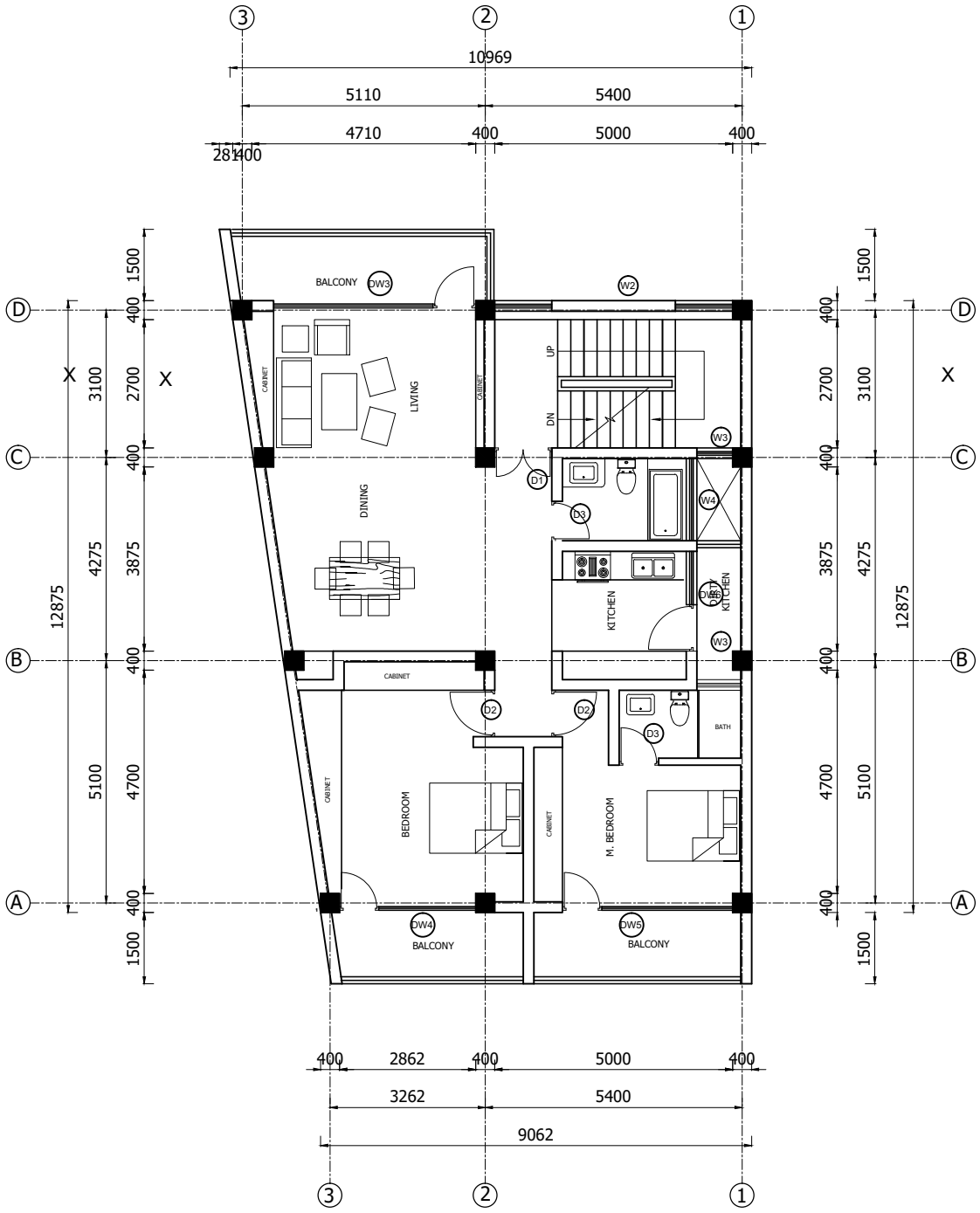
AREA = 128.95 sq. m.

Scale 1:100



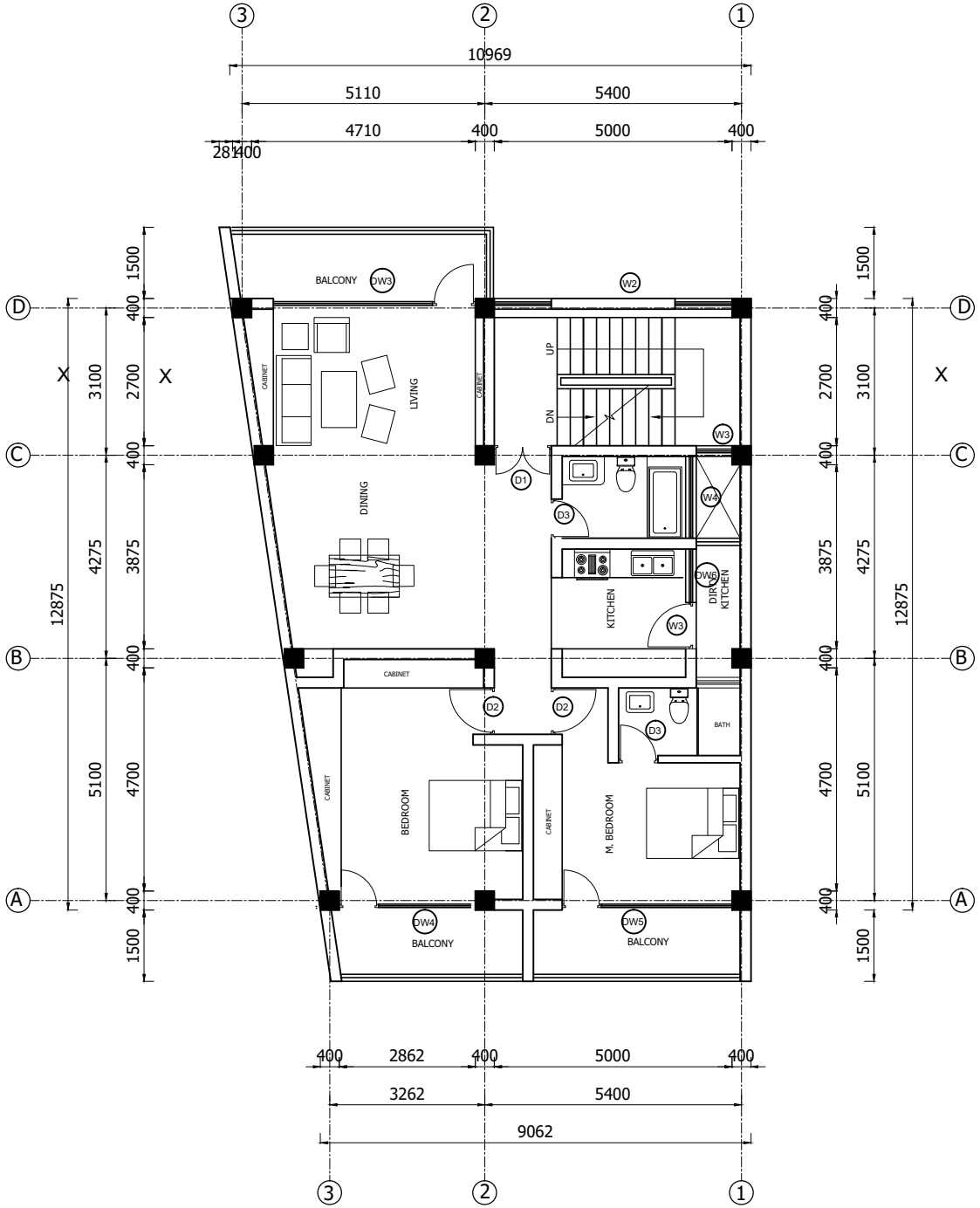
FIRST FLOOR PLAN

AREA = 128.95 sq. m.



2ND FLOOR PLAN

AREA = 128.95 sq. m.

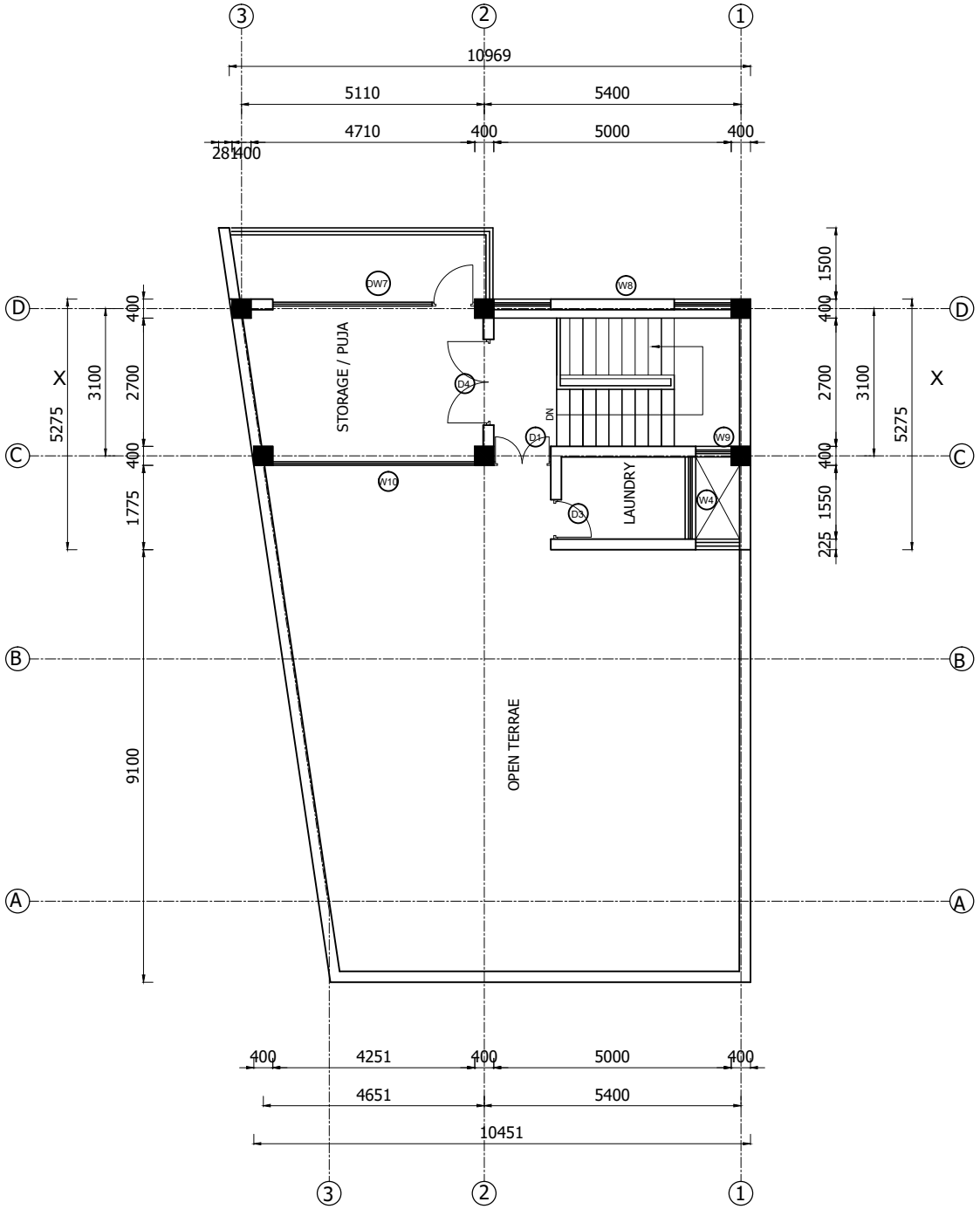


N

3RD FLOOR PLAN

AREA = 128.95 sq. m.

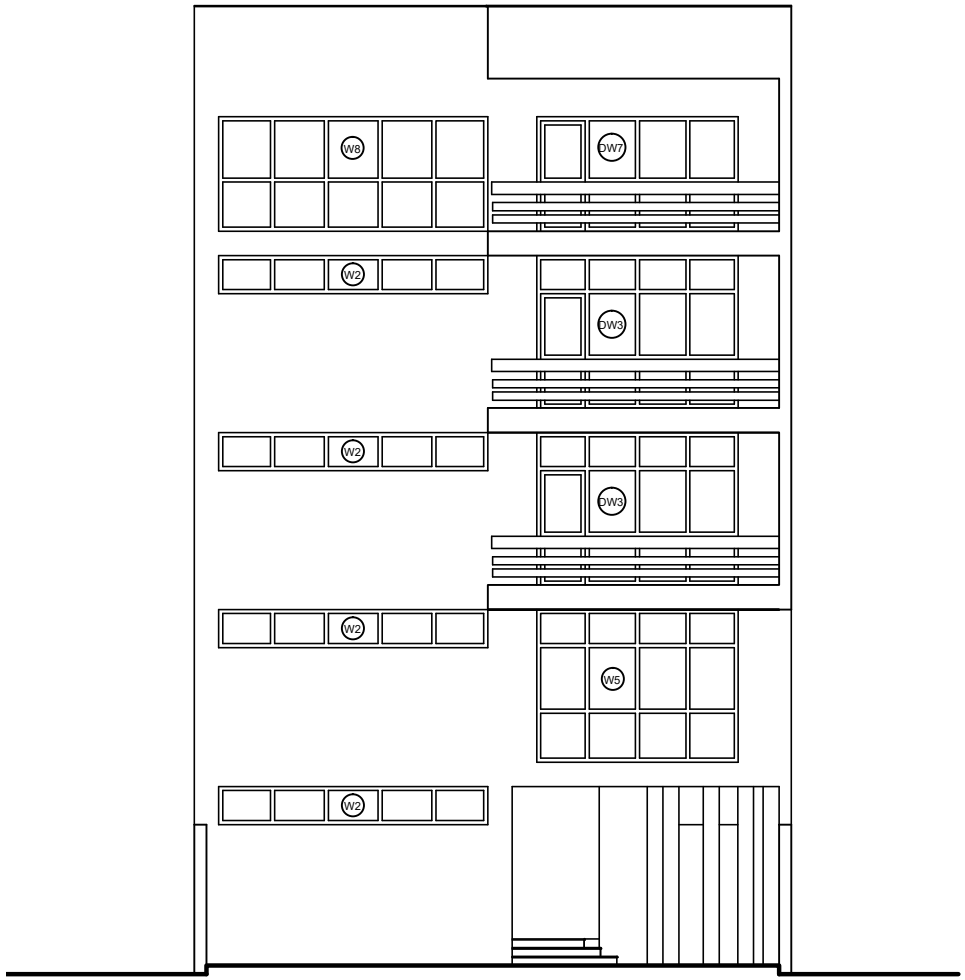
Scale 1:100



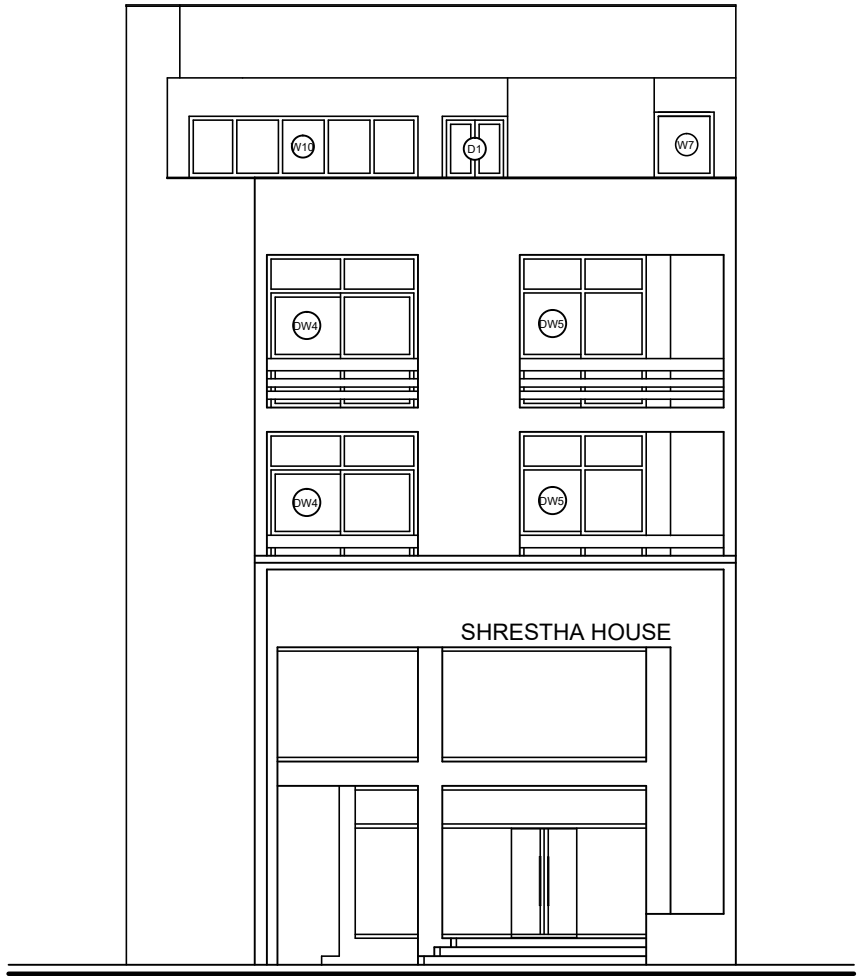
TOP FLOOR PLAN

AREA = 44.95 sq. m.

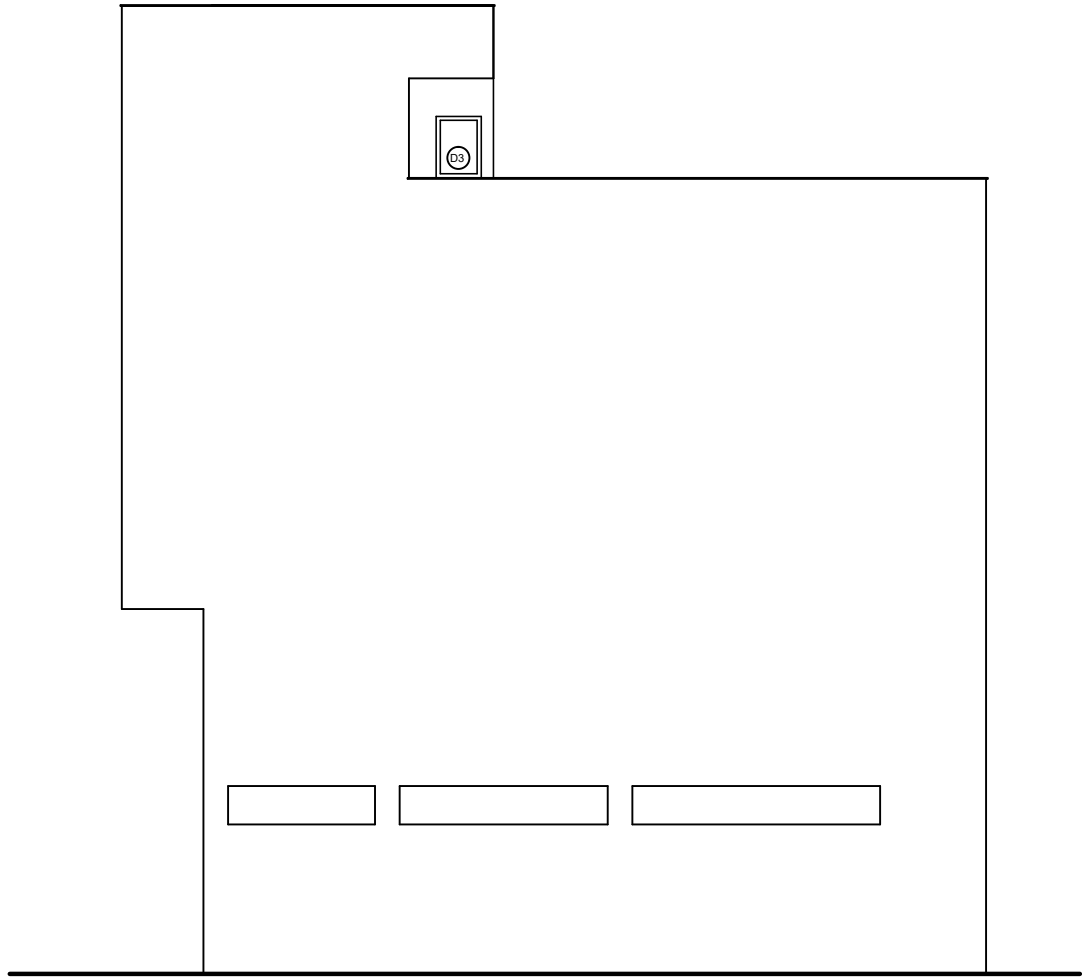
Scale 1:100



EAST ELEVATION

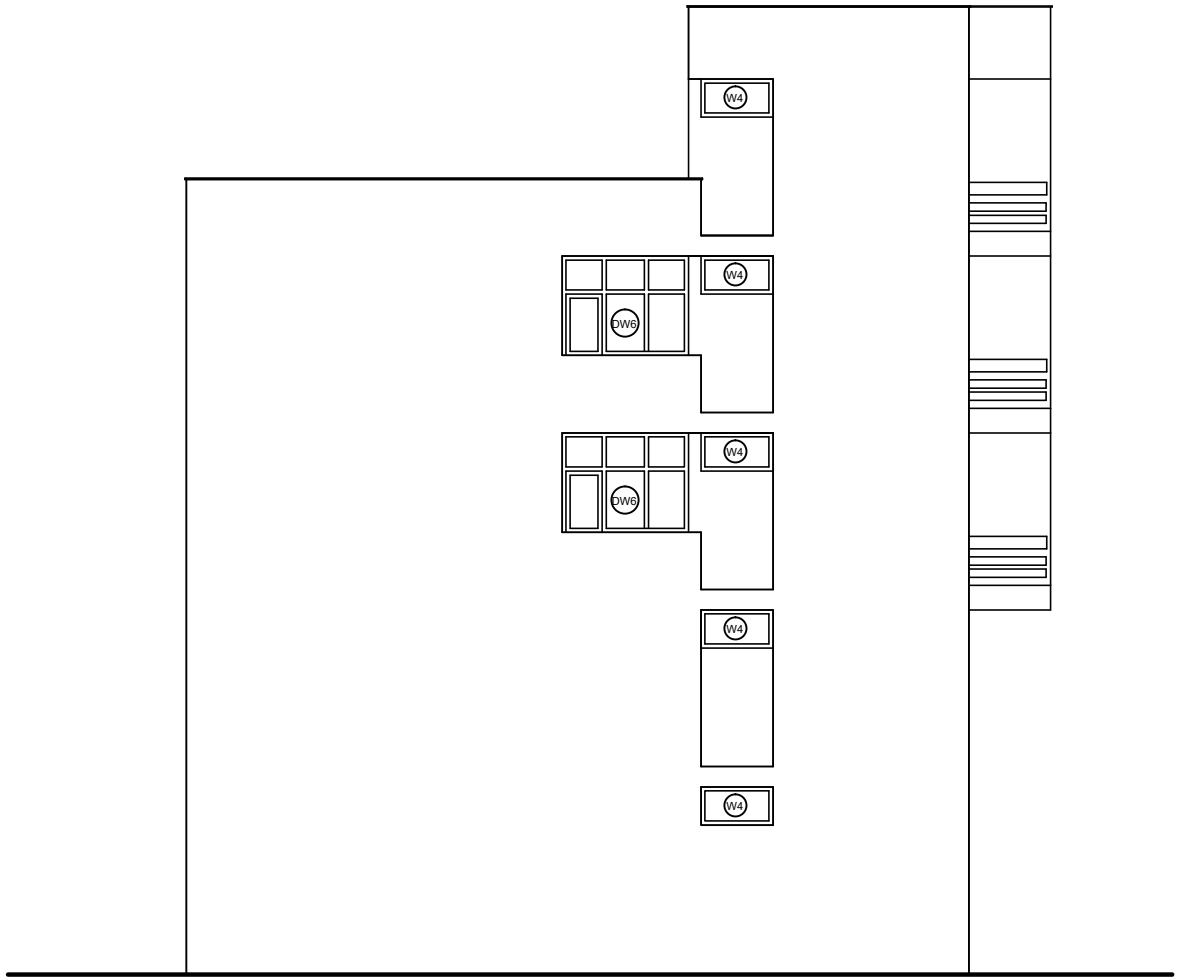


WEST ELEVATION



NORTH ELEVATION

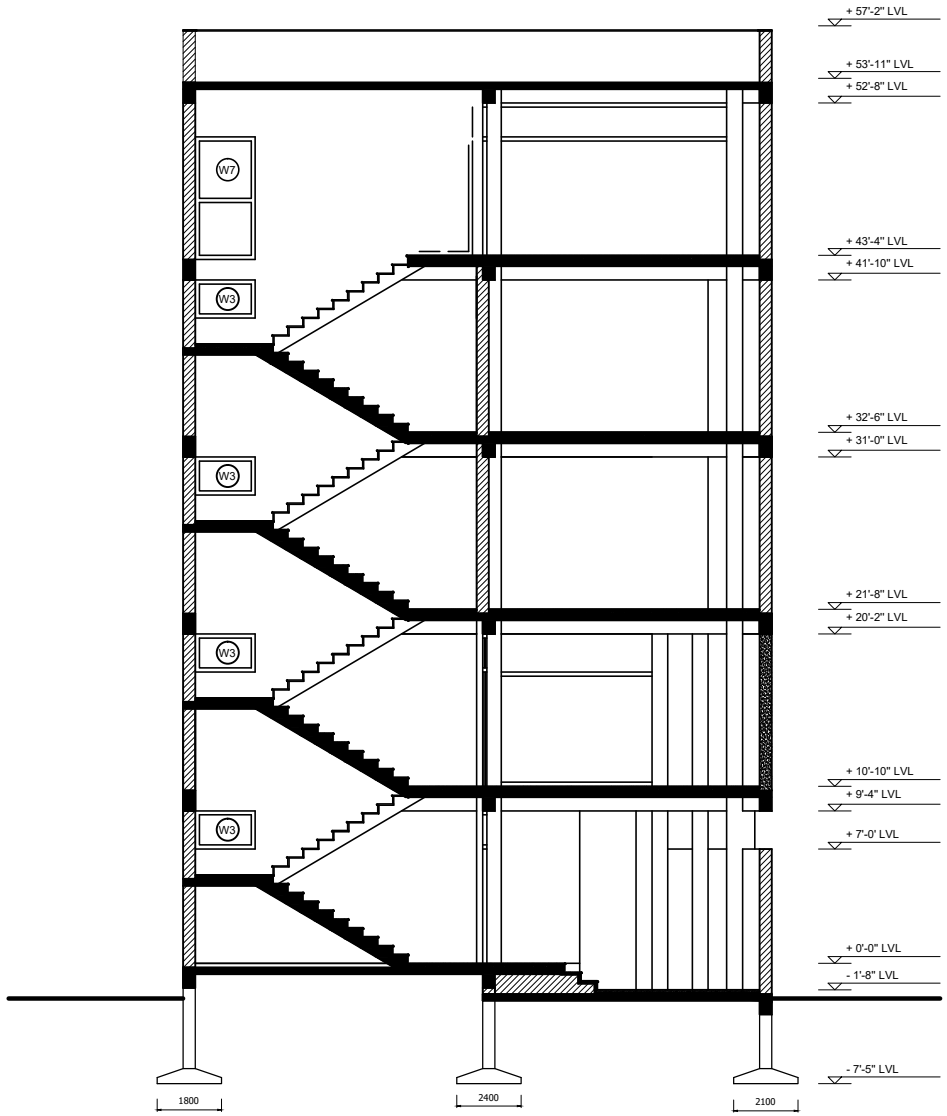
Scale 1:100



SOUTH ELEVATION

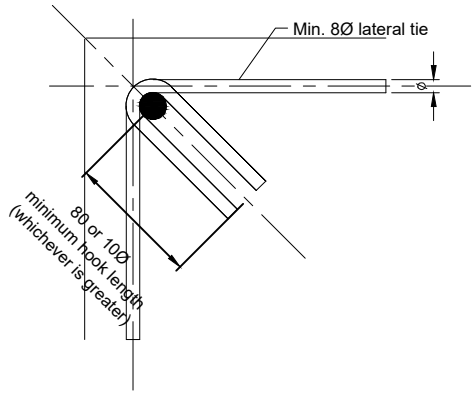
OPENING SCHEDULES

SYMBOL	DISCRIPTION	SIZE	QUANTITY	REMARKS
W1	WINDOW	7850 X 2800	1	ALUMINIUM
W2	WINDOW	5000 X 700	4	ALUMINIUM
W3	WINDOW	1100 X 700	6	ALUMINIUM
W4	WINDOW	4'-5" X 2'-4"	5	ALUMINIUM
W5	WINDOW	3750 X 2800	1	ALUMINIUM
W6	WINDOW	2825 X 2100	1	ALUMINIUM
W7	WINDOW	3725 X 2100	1	ALUMINIUM
W8	WINDOW	5025 X 2100	1	ALUMINIUM
W9	WINDOW	4200 X 1125	1	ALUMINIUM
W10	WINDOW	2100 X 700	1	ALUMINIUM
DW1	DOOR WINDOW	2825 X 2800	1	ALUMINIUM
DW2	DOOR WINDOW	2750 X 2800	2	ALUMINIUM
DW3	DOOR WINDOW	3750 X 2800	2	ALUMINIUM
DW4	DOOR WINDOW	2825 X 2800	2	ALUMINIUM
DW5	DOOR WINDOW	2250 X 2800	2	ALUMINIUM
DW6	DOOR WINDOW	2350 X 2800	1	ALUMINIUM
DW7	DOOR WINDOW	3750 X 2100	1	ALUMINIUM
D1	DOOR	1200 X 2100	4	WOODEN
D2	DOOR	975 X 2100	4	WOODEN
D3	DOOR	825 X 2100	7	WOODEN
D4	DOOR	1800 X 2100	1	WOODEN



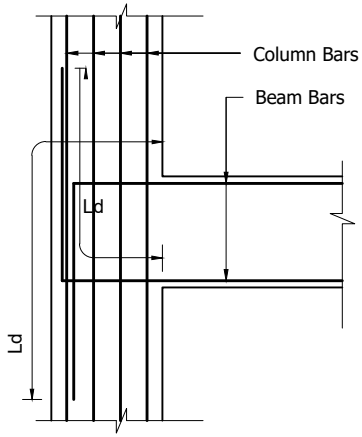
SECTION THROUGH X-X

Scale 1:100



DETAIL A-135°HOOK DETAIL
FOR STIRRUPS & TIES

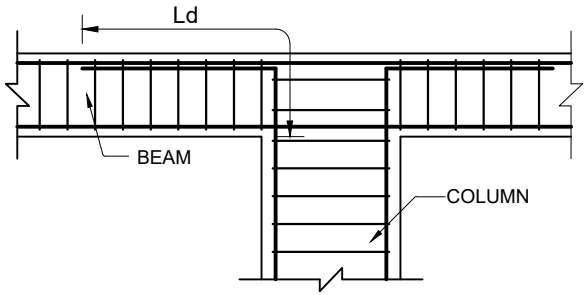
SCALE=1:10



Ld = Development Length = 60Ø

ANCHORAGE OF BEAM BARS
IN AN EXTERNAL JOINT

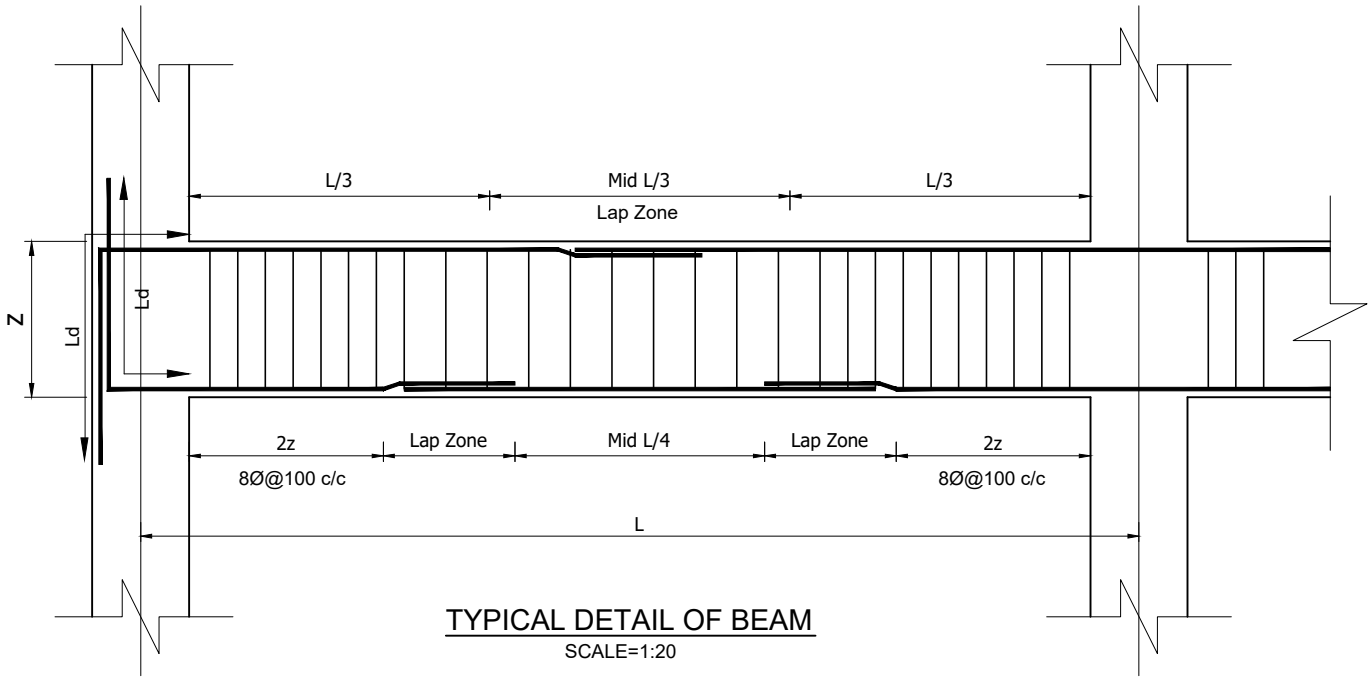
SCALE=1:20



Ld = 60Ø

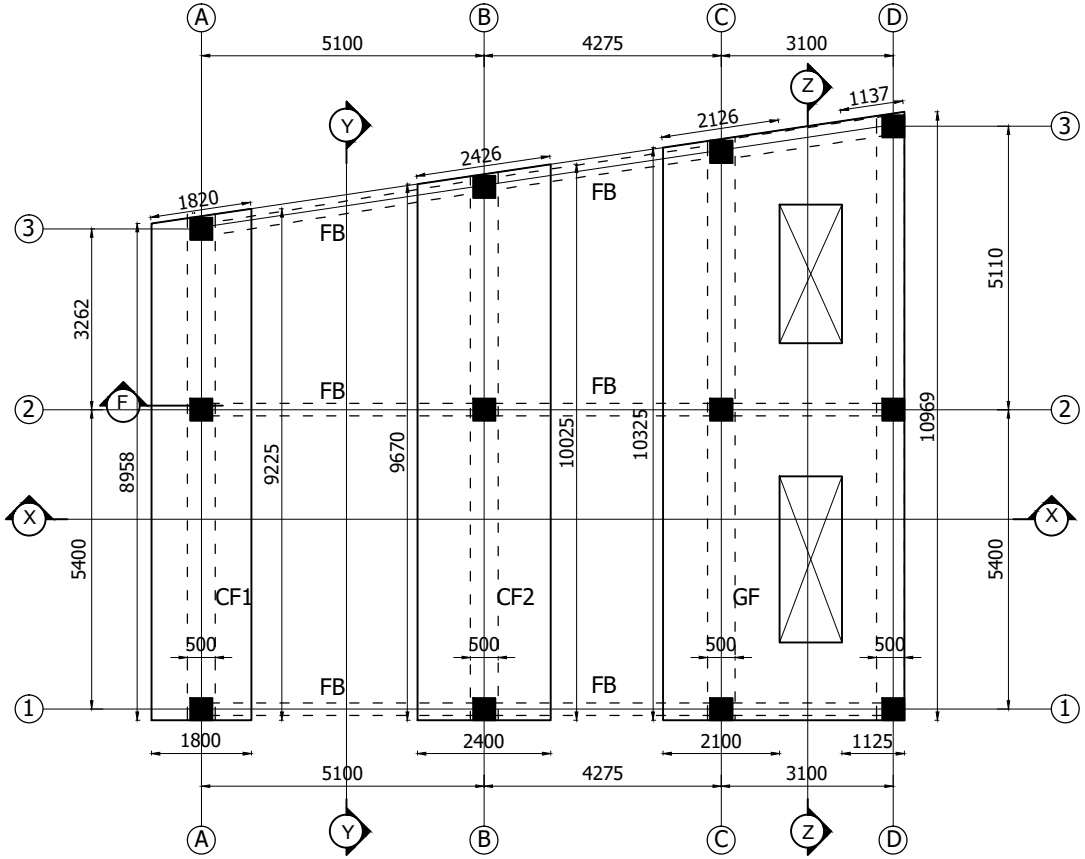
COLUMN BAR ANCHORAGE DETAIL
IN ROOF BEAM

SCALE=1:20



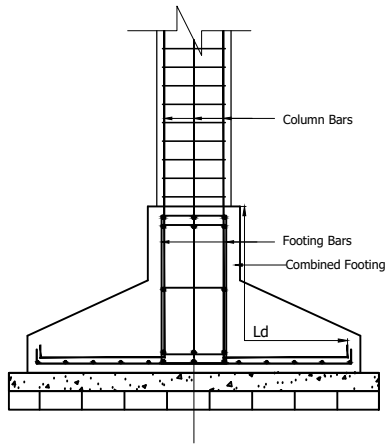
TYPICAL DETAIL OF BEAM

SCALE=1:20



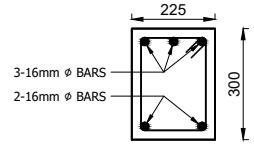
FOUNDATION LAYOUT PLAN

Grade of Concrete = M20
Grade of Steel = Fe 415

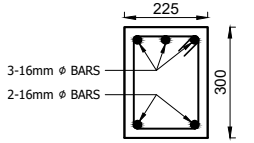


SECTION AT F- F

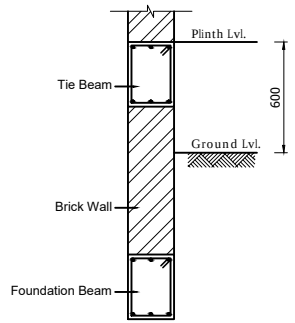
Ld = Development Length = 60Ø



TIE BEAM

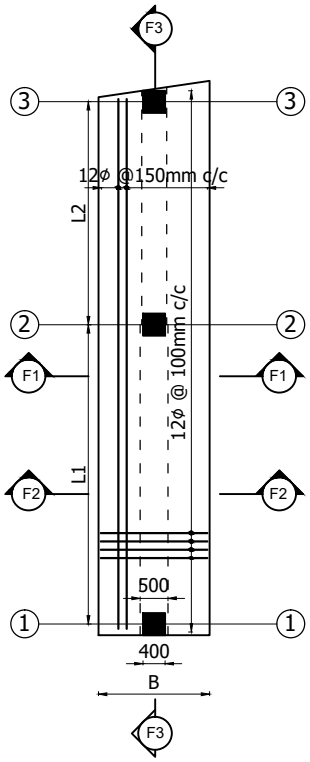


FOUNDATION BEAM

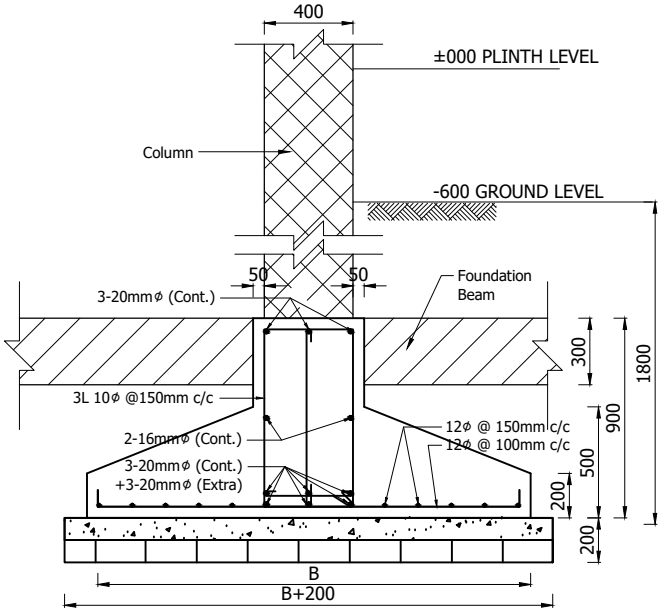


SECTION OF TOE WALL

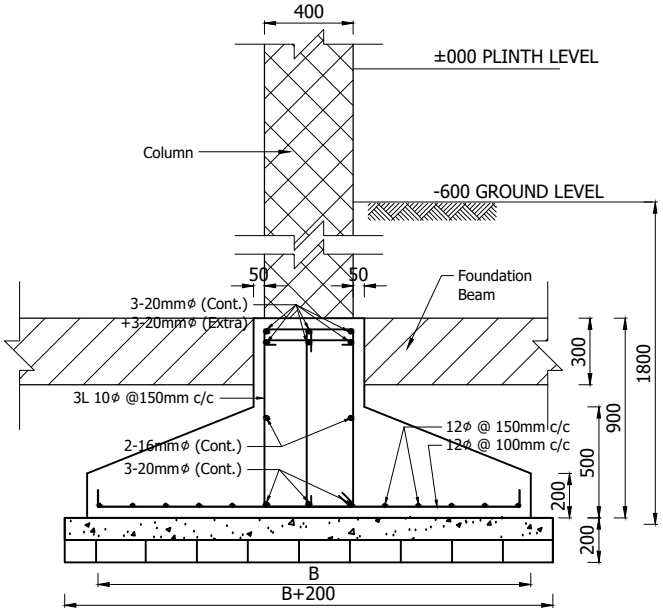
Scale 1:00
1:30



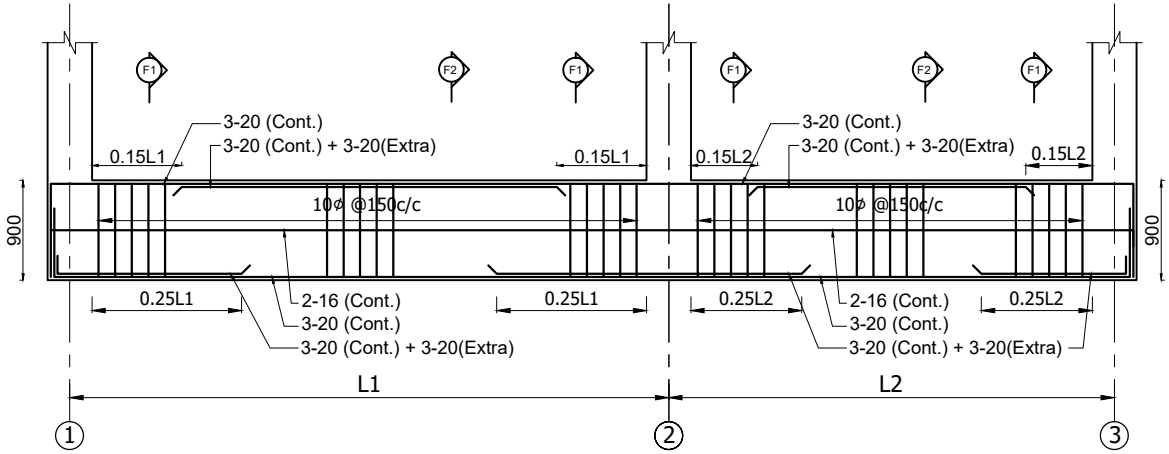
TYPICAL COMBINED FOOTING PLAN



SECTION AT F1 - F1

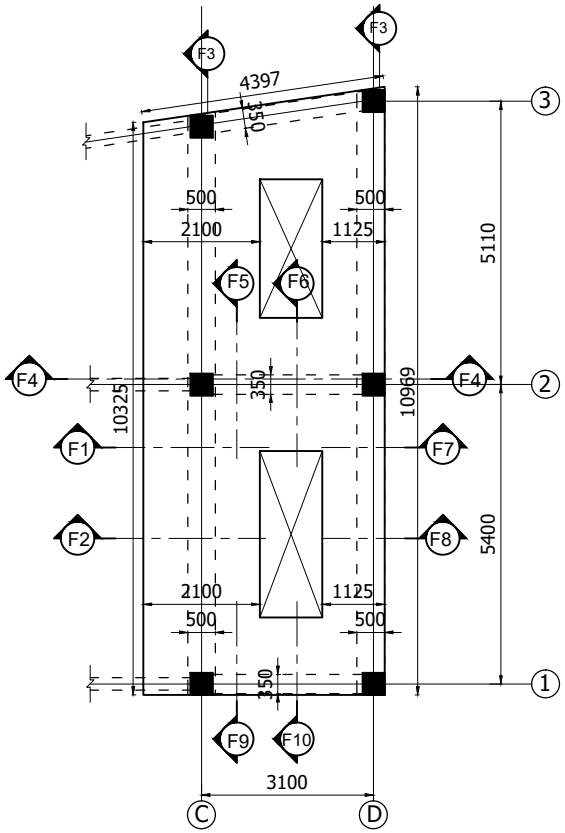


SECTION AT F2 - F2

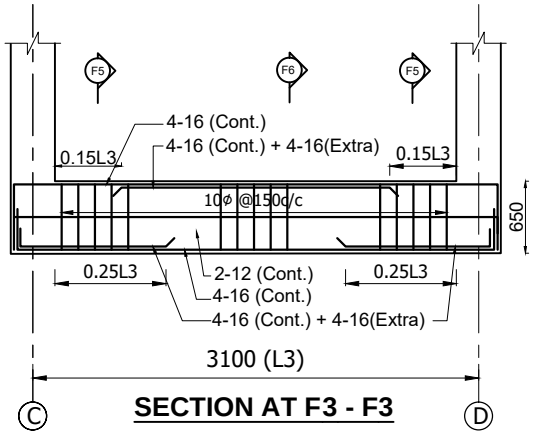


SECTION AT F3 - F3

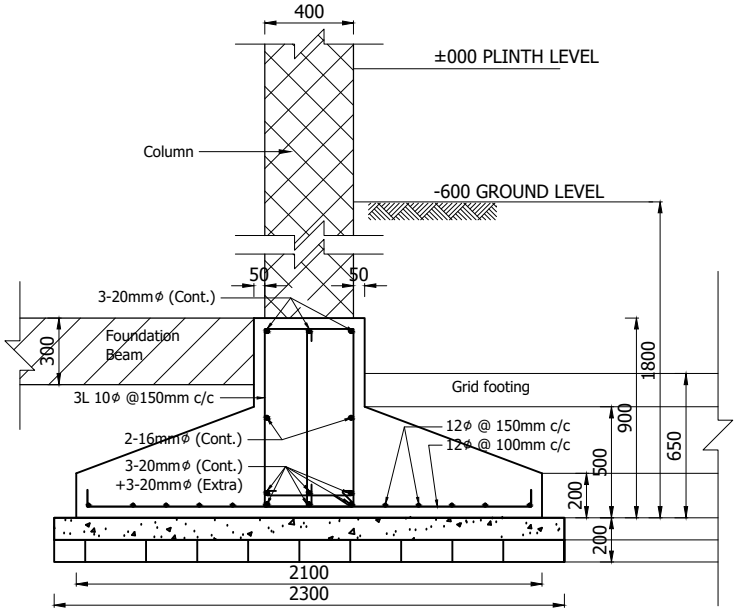
Scale 1:50
1:25



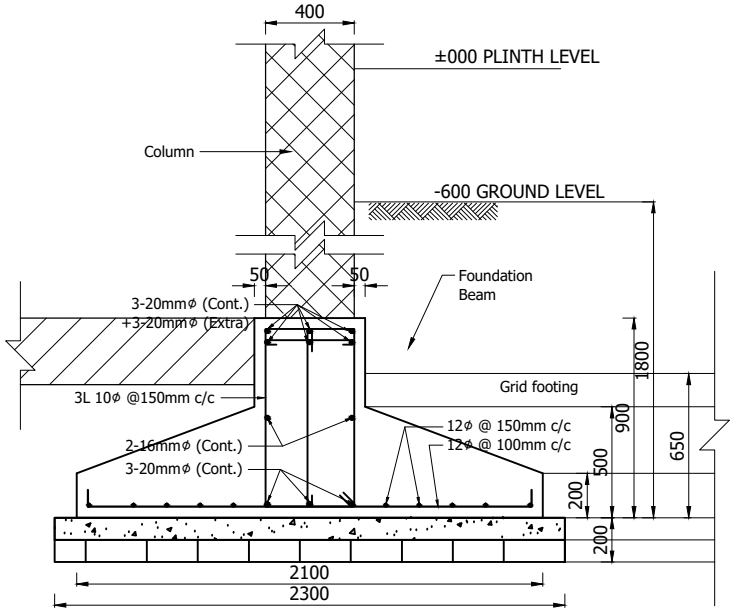
GRID FOOTING PLAN



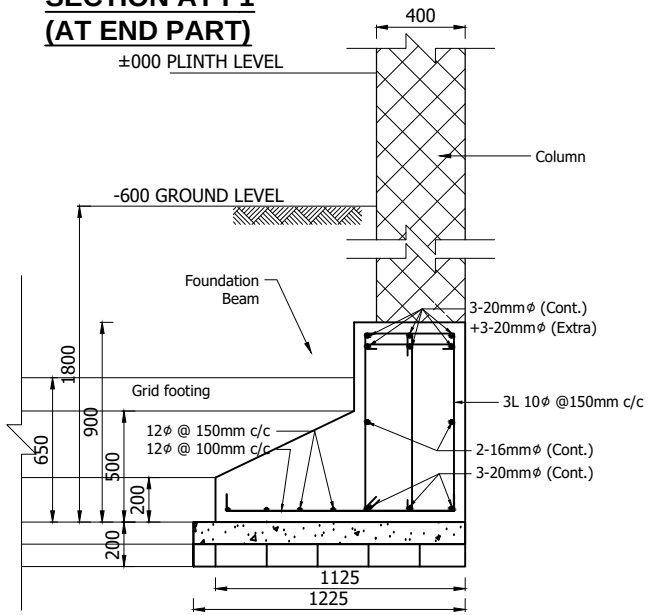
SECTION AT F3 - F3



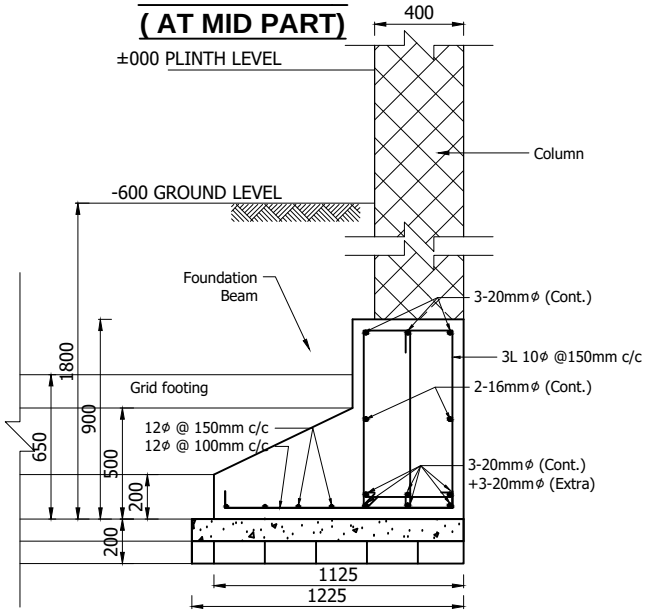
SECTION AT F1
(AT END PART)



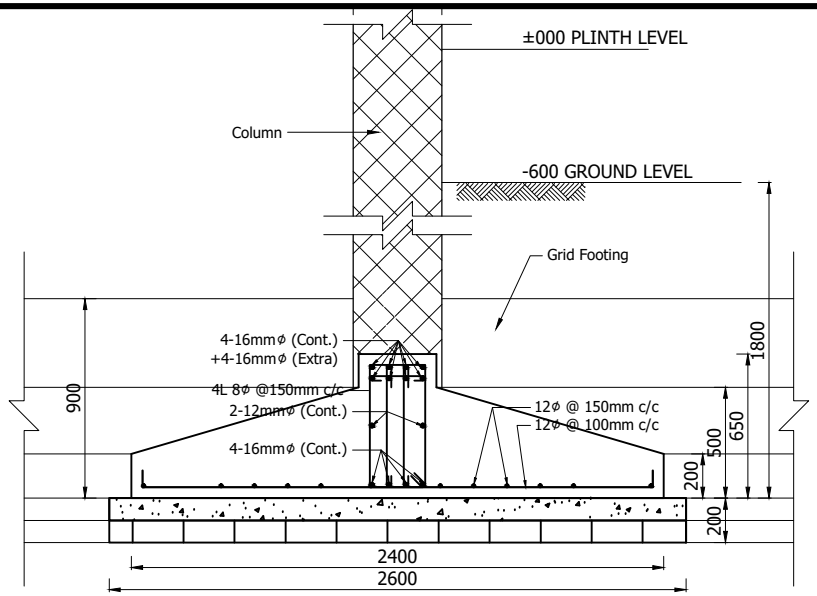
SECTION AT F2
(AT MID PART)



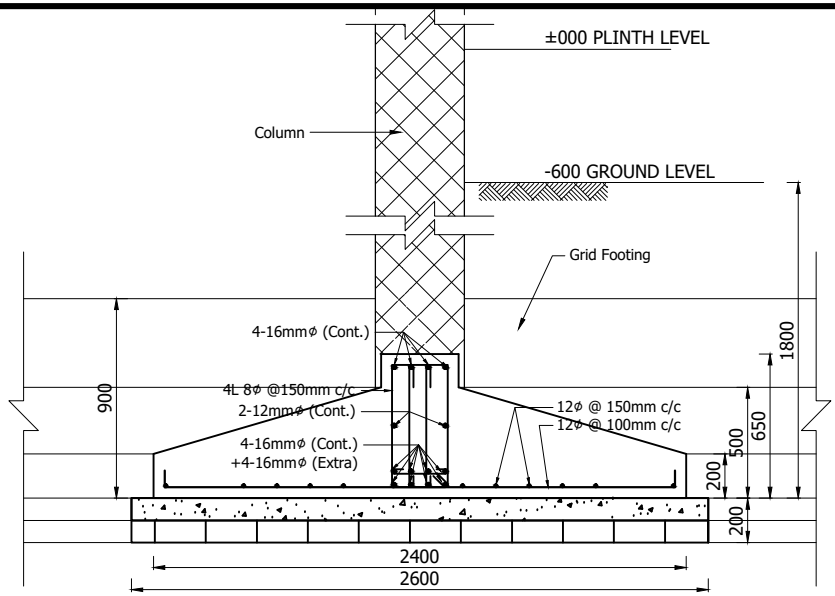
SECTION AT F7
(AT END PART)



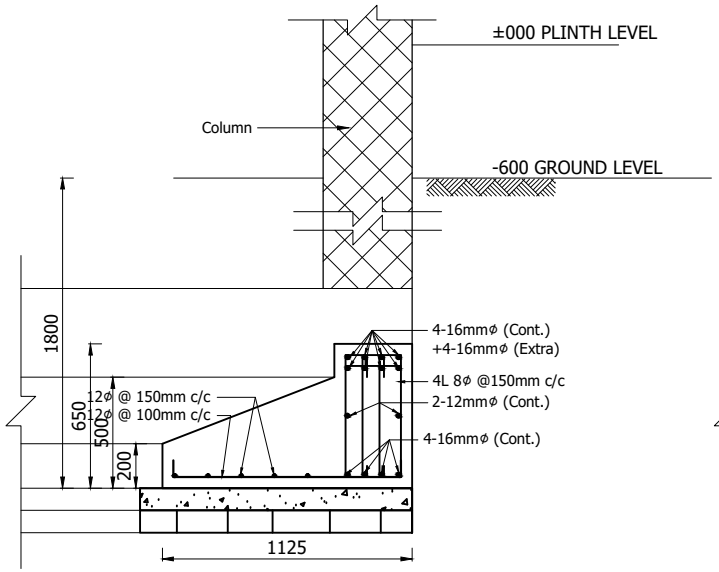
SECTION AT F8
(AT MID PART)



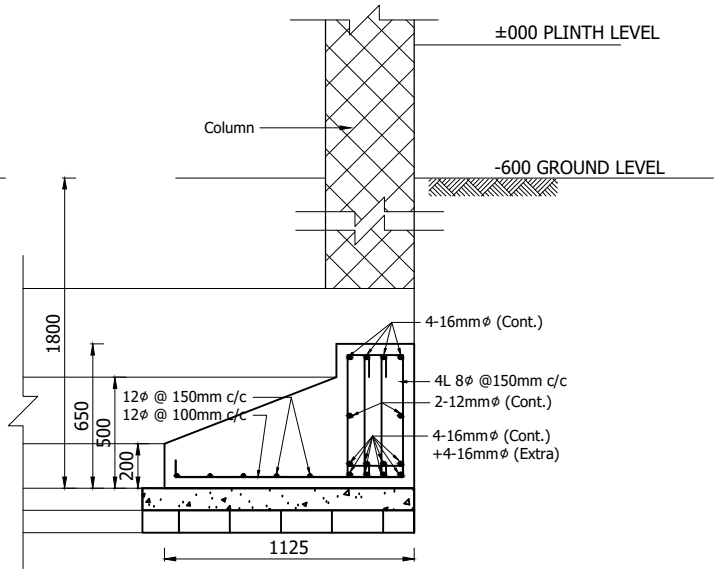
SECTION AT F5
(AT MID PART)



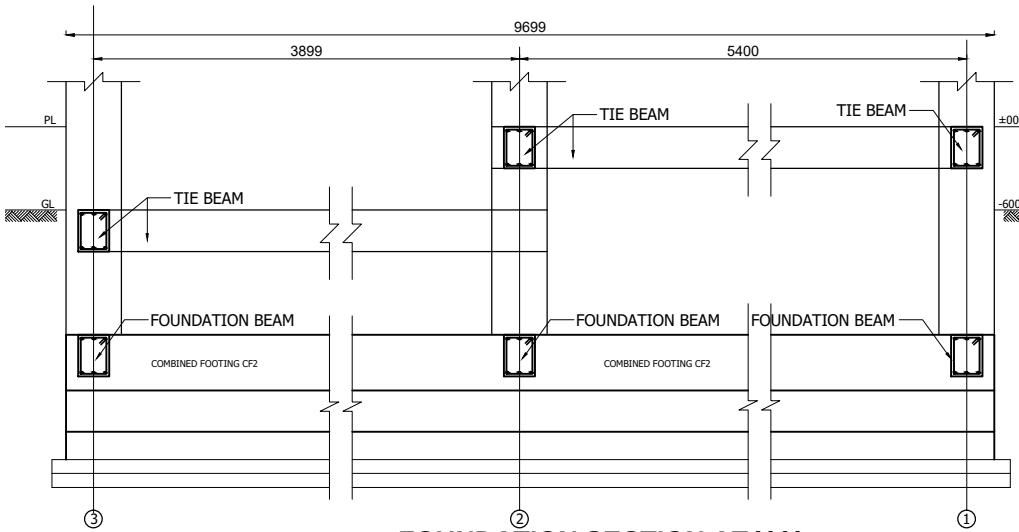
SECTION AT F6
(AT END PART)



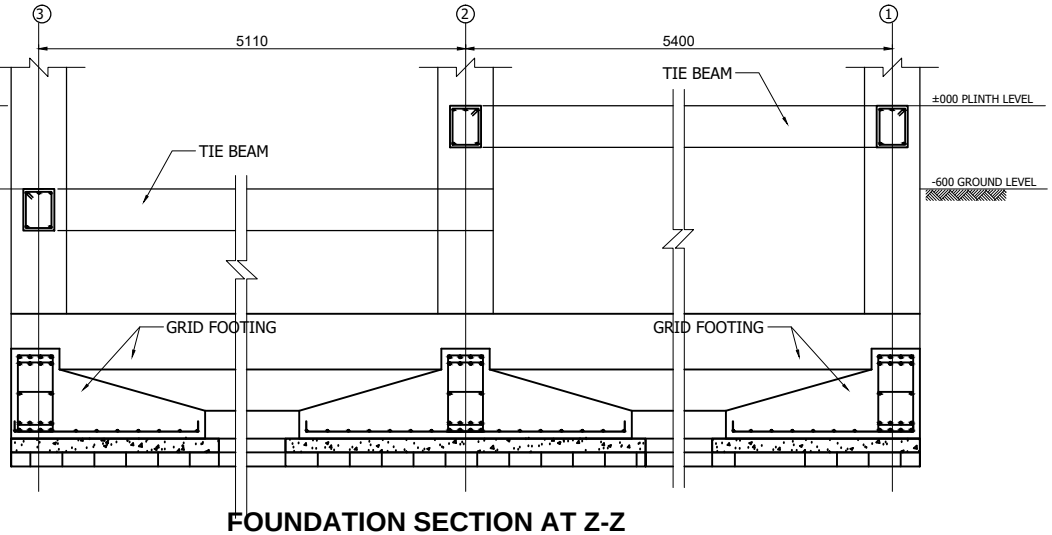
SECTION AT F9
(AT MID PART)



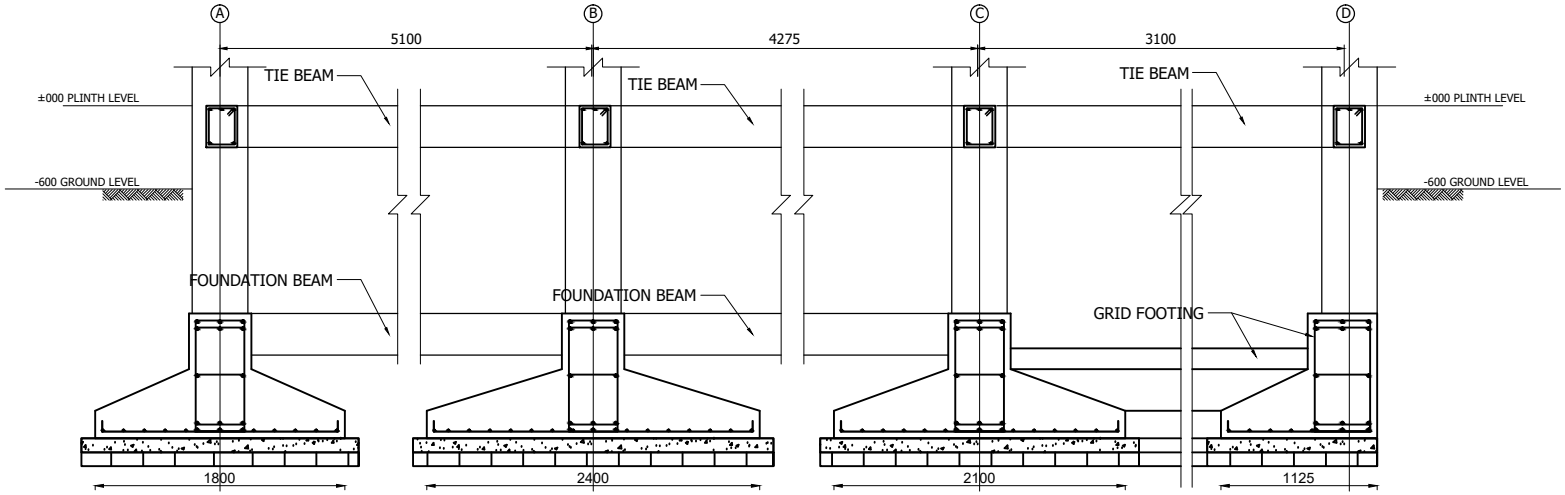
SECTION AT F10
(AT END PART)



FOUNDATION SECTION AT Y-Y

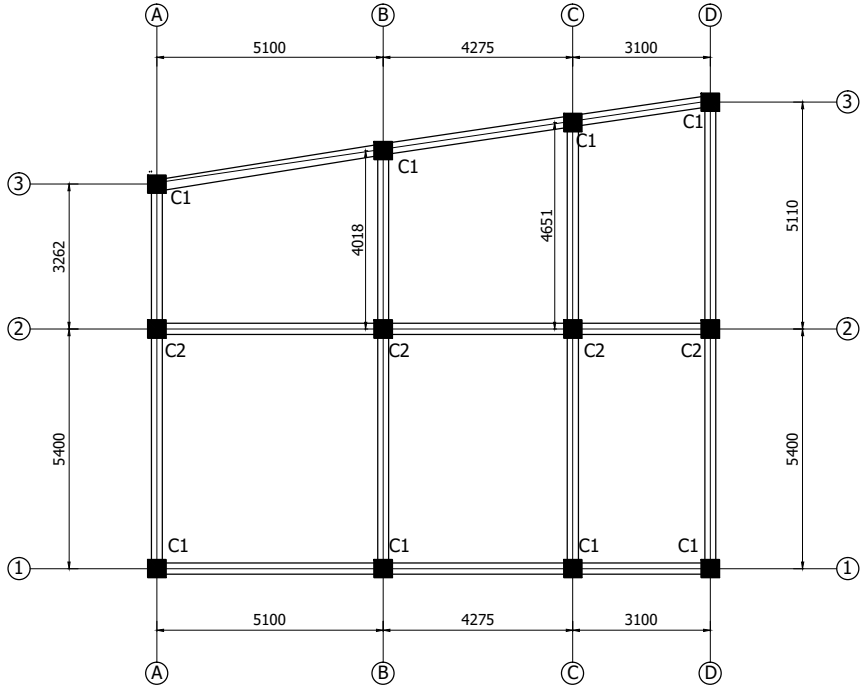


FOUNDATION SECTION AT Z-Z



FOUNDATION SECTION AT X-X

Scale 1:25

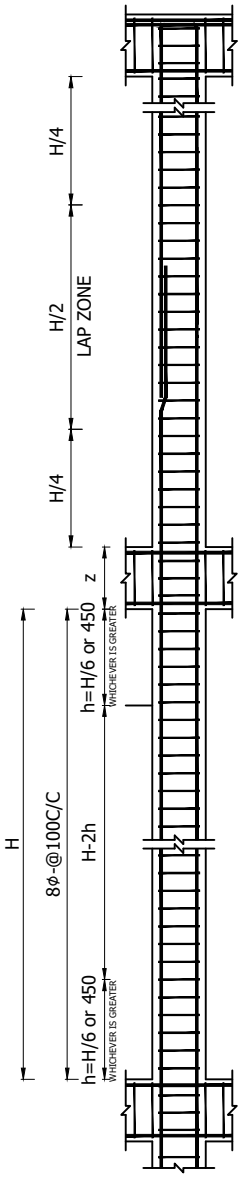


BEAM/COLUMN LAYOUT PLAN

COLUMN REINFORCEMENT DETAIL

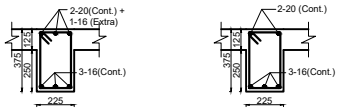
Grade of Concrete = M25
Grade of Steel = Fe 415

S. No.	TYPE	GRID	COLUMN SIZE	FLOOR	REINFORCEMENT			SECTIONS	SHAPE OF STIRRUPS
					LONGITUDINAL	LATERAL TIES			
						End Ties (h+z)	Mid Ties (H-2h)		
1.	C1	1A, 1B, 1C, 1D, 3A, 3B, 3C, 3D	400 X 400	FROM FOUNDATION TO GROUND FLOOR	4-20 Ï + 4-25 Ï	8 Ï @ 100c/c	8 Ï @ 100c/c	2-25ϕ, 4-20ϕ, 2-25ϕ	+
				FIRST FLOOR TO TOP FLOOR	8-20 Ï	8 Ï @ 100c/c	8 Ï @ 100c/c	8-20ϕ	+
2.	C2	2A, 2B, 2C, 2D	400 X 400	FROM FOUNDATION TO TOP	4-20 Ï + 4-25 Ï	8 Ï @ 100c/c	8 Ï @ 100c/c	2-25ϕ, 4-20ϕ, 2-25ϕ	+



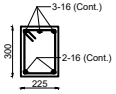
TYPICAL L-SECTION DETAIL OF COLUMN

SCALE=1:25

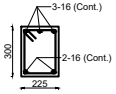


Section 3-3

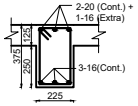
Section 4-4



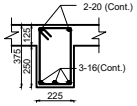
Section 1-1
(TIE BEAM)



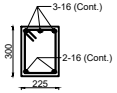
Section 2-2
(TIE BEAM)



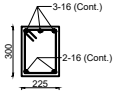
Section 3-3



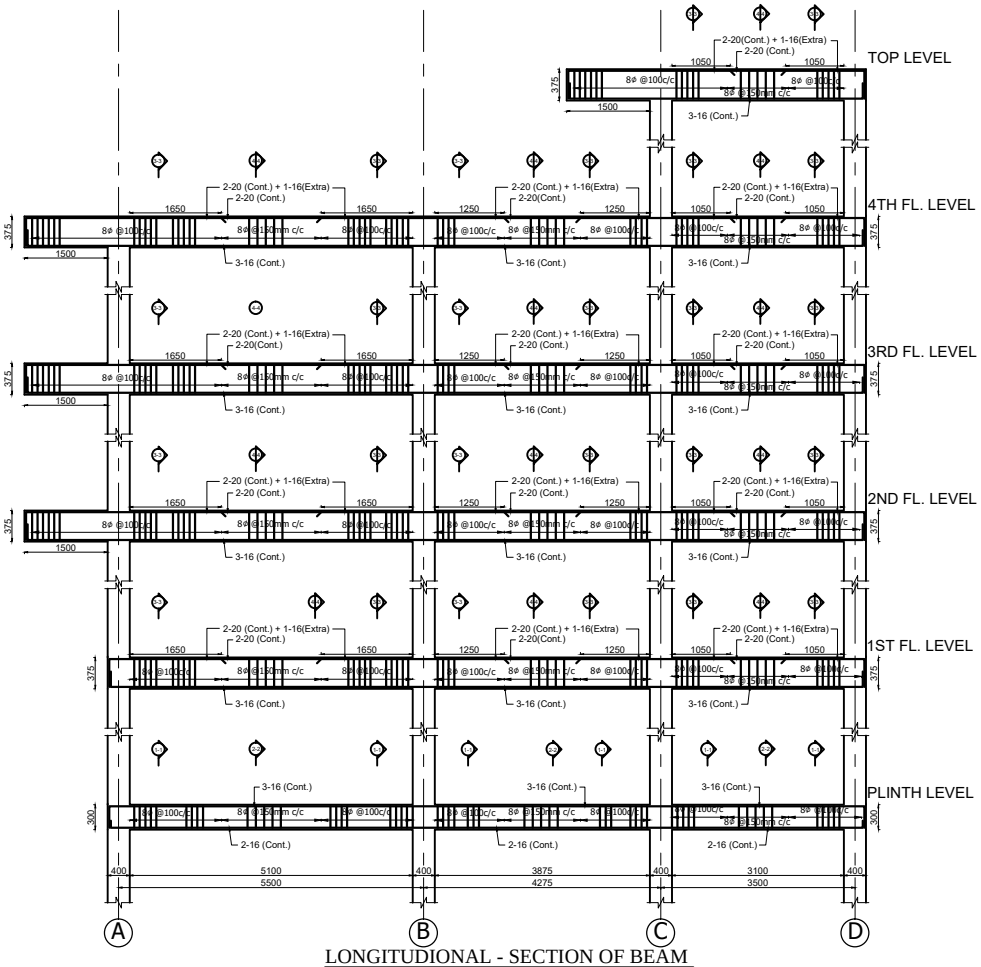
Section 4-4



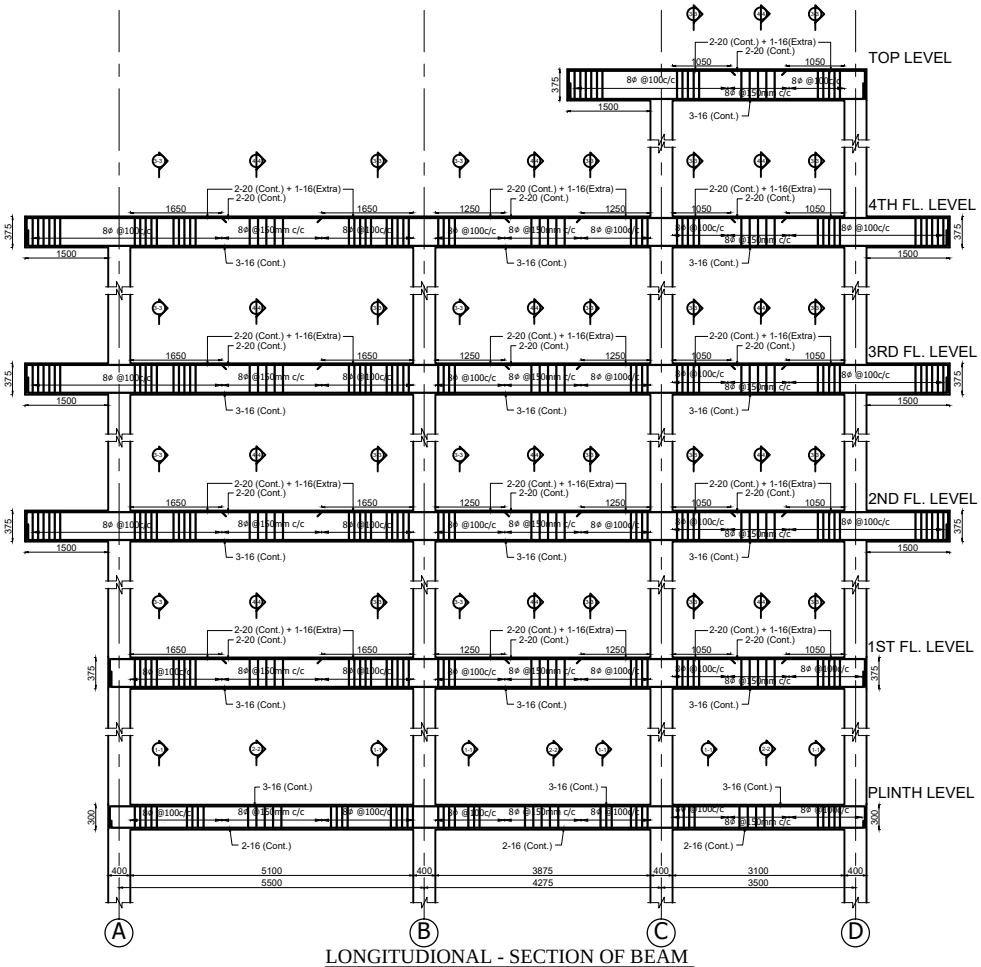
Section 1-1
(TIE BEAM)



Section 2-2
(TIE BEAM)

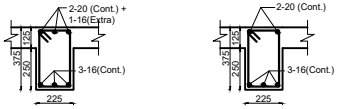


LONGITUDIONAL - SECTION OF BEAM
ALONG GRID 1-1



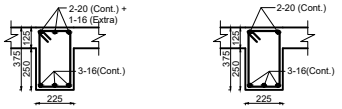
LONGITUDIONAL - SECTION OF BEAM
ALONG GRID 2-2 & 3-3

Scale 1:100

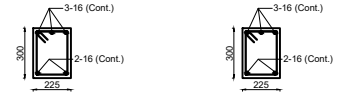


Section 3-3 Section 4-4

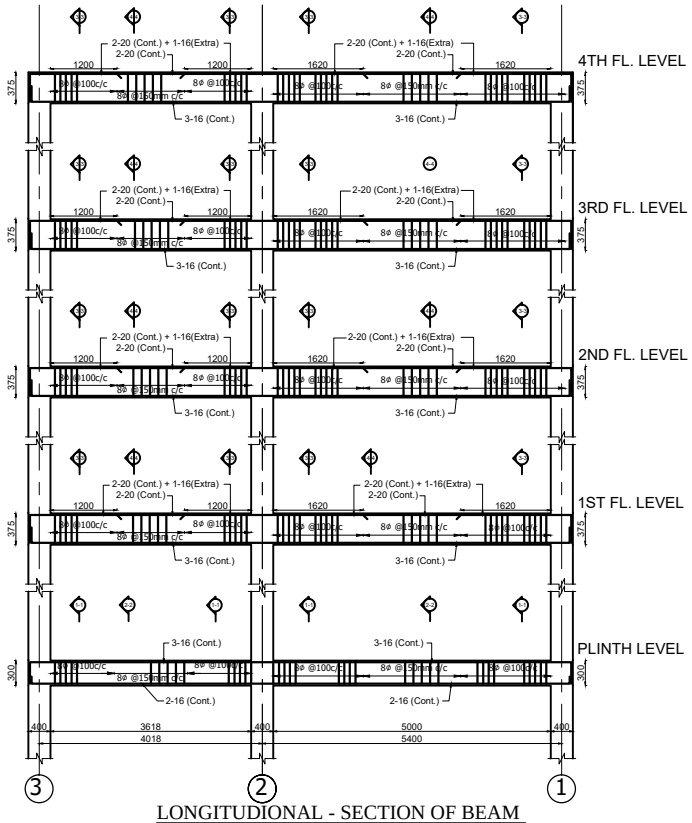
Section 1-1 (TIE BEAM) Section 2-2 (TIE BEAM)



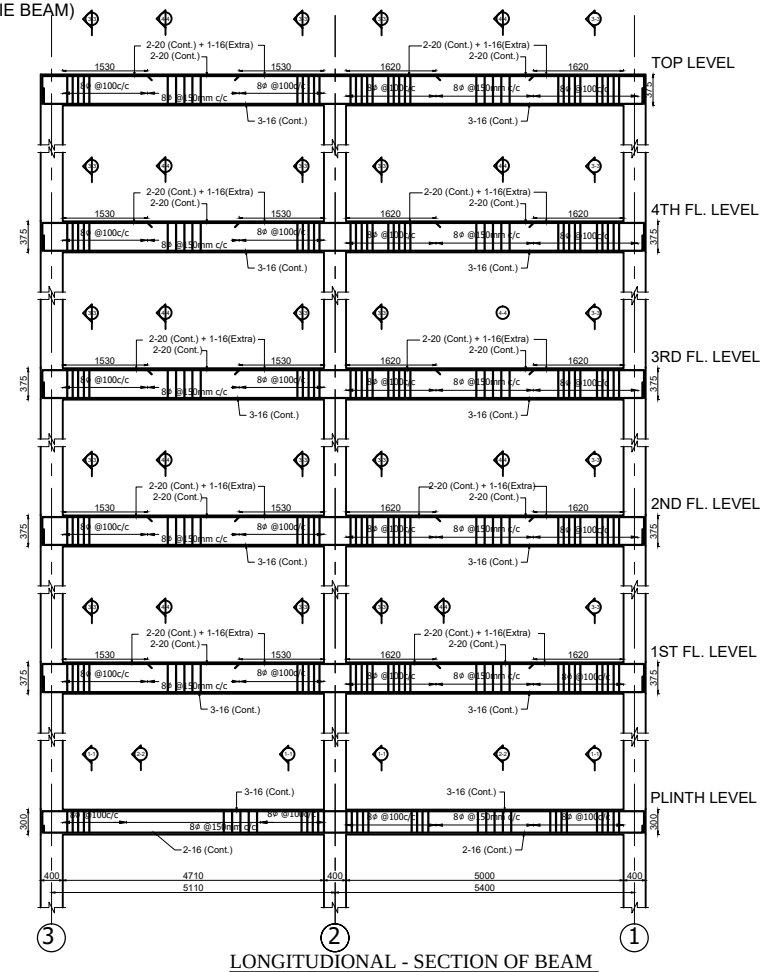
Section 3-3 Section 4-4



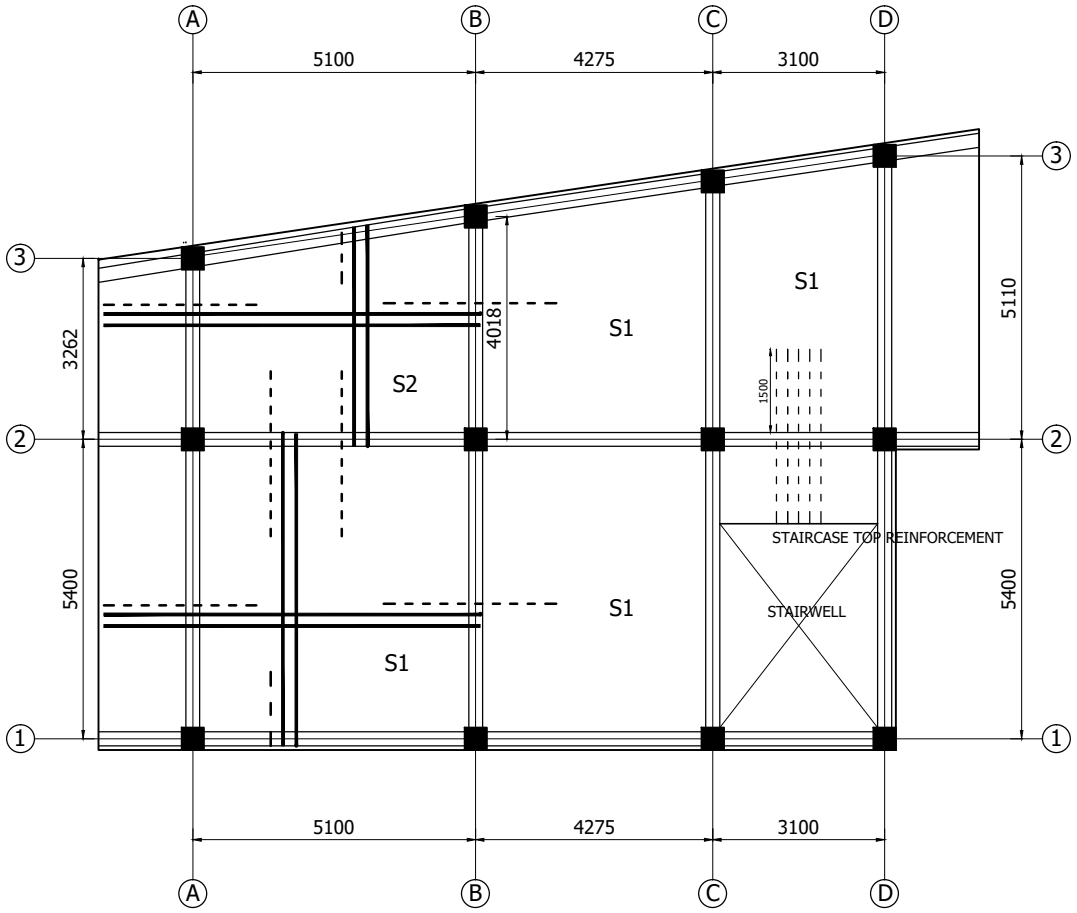
Section 1-1 (TIE BEAM) Section 2-2 (TIE BEAM)



LONGITUDIONAL - SECTION OF BEAM ALONG GRID A-A & B-B

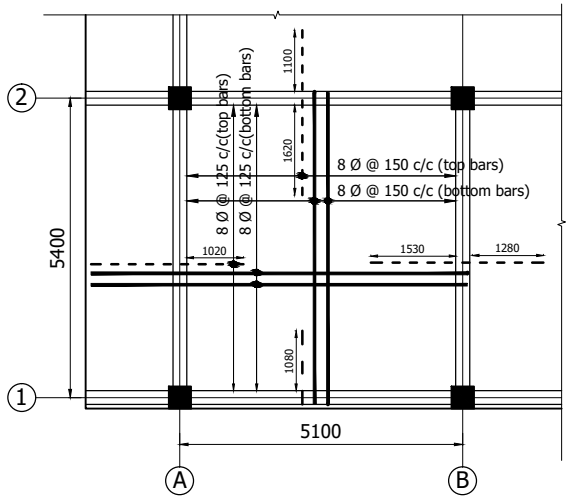


LONGITUDIONAL - SECTION OF BEAM ALONG GRID C-C & D-D



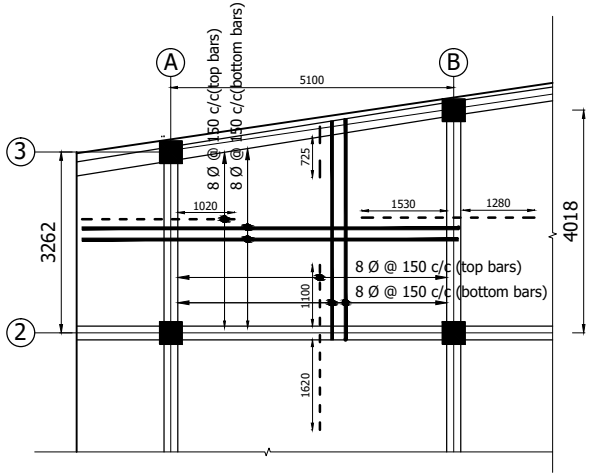
TYPICAL SLAB DETAIL

SLAB THICKNESS = 125mm



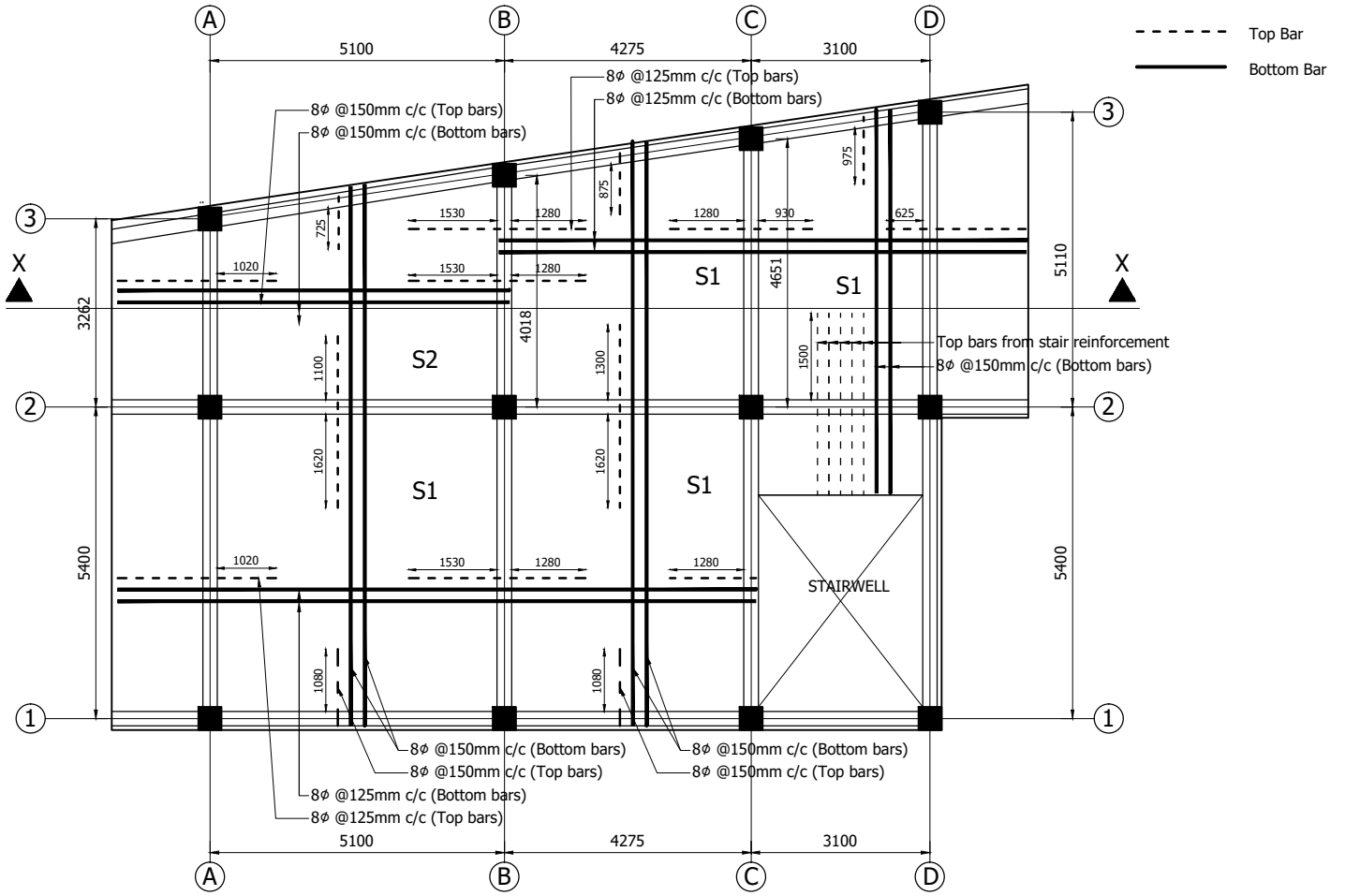
DETAILS OF SLAB-S1

SCALE 1:100



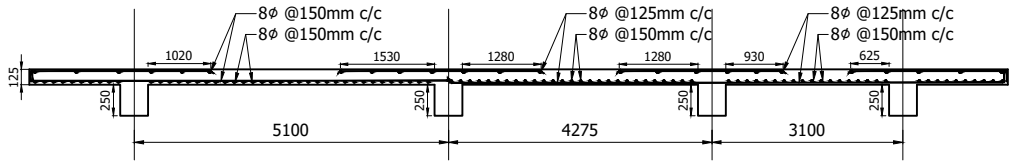
DETAILS OF SLAB-S2

SCALE 1:100

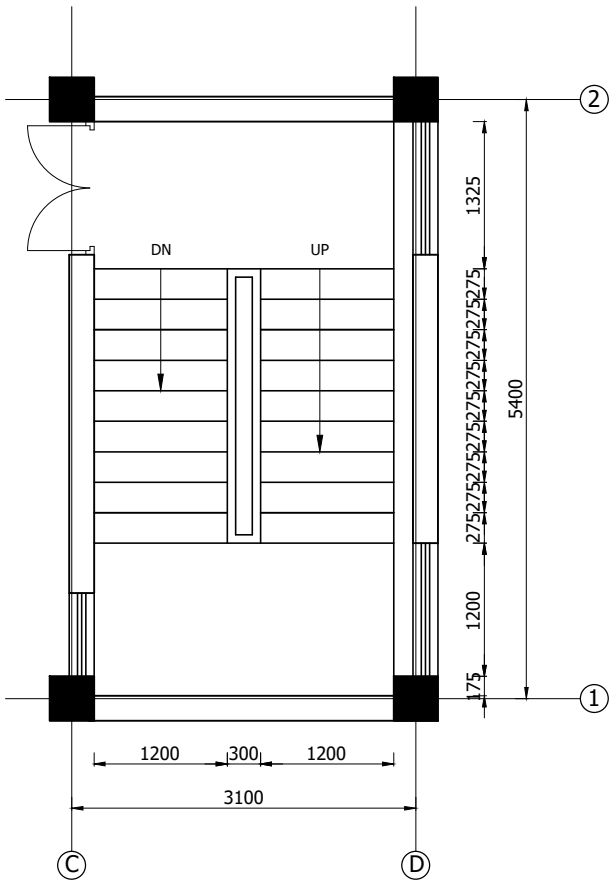


TYPICAL SLAB DETAIL

SLAB THICKNESS = 125mm

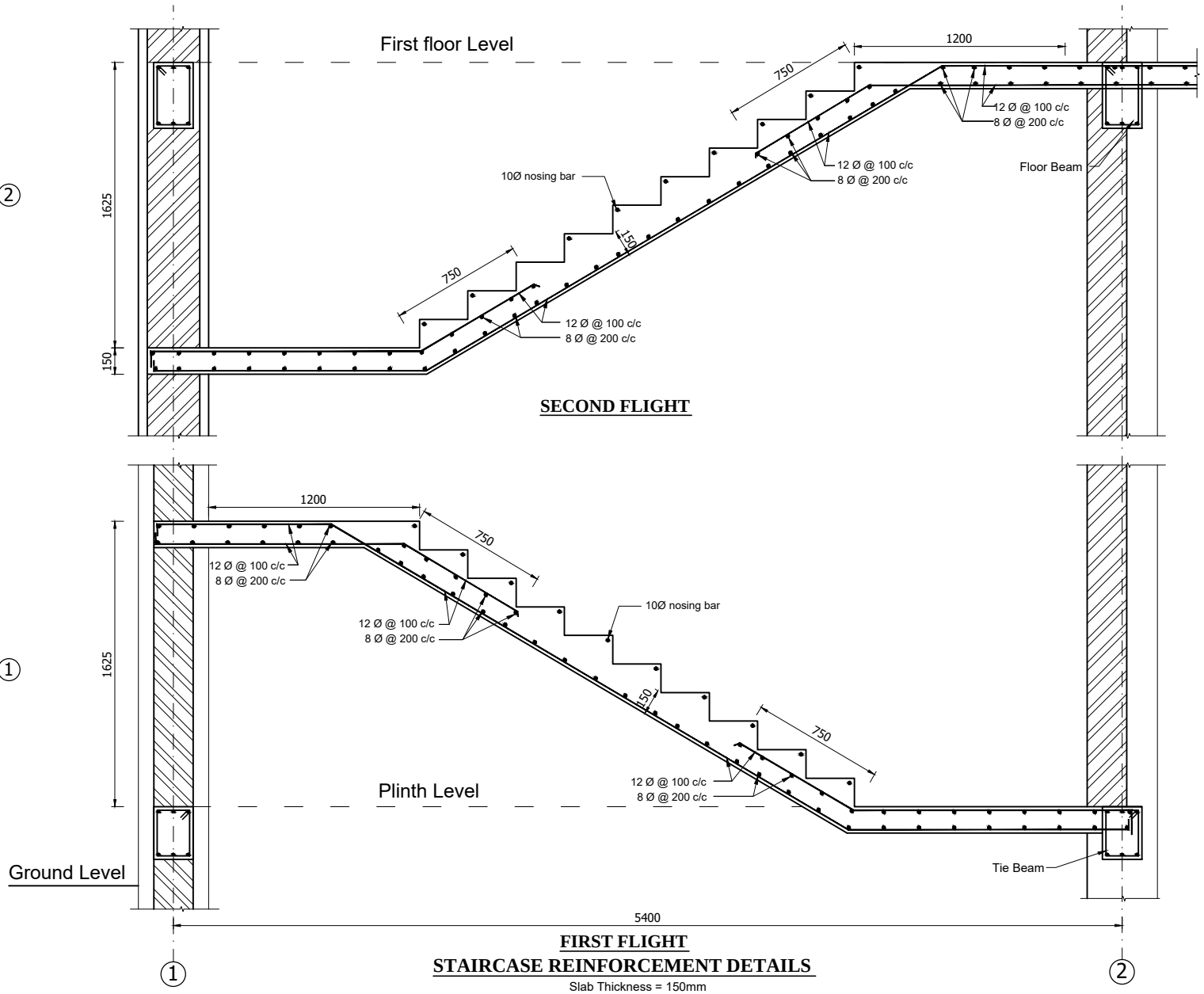


SECTION AT X-X



STAIRCASE PLAN

Slab Thickness = 150mm
Riser = 162.5mm
Tread = 275mm



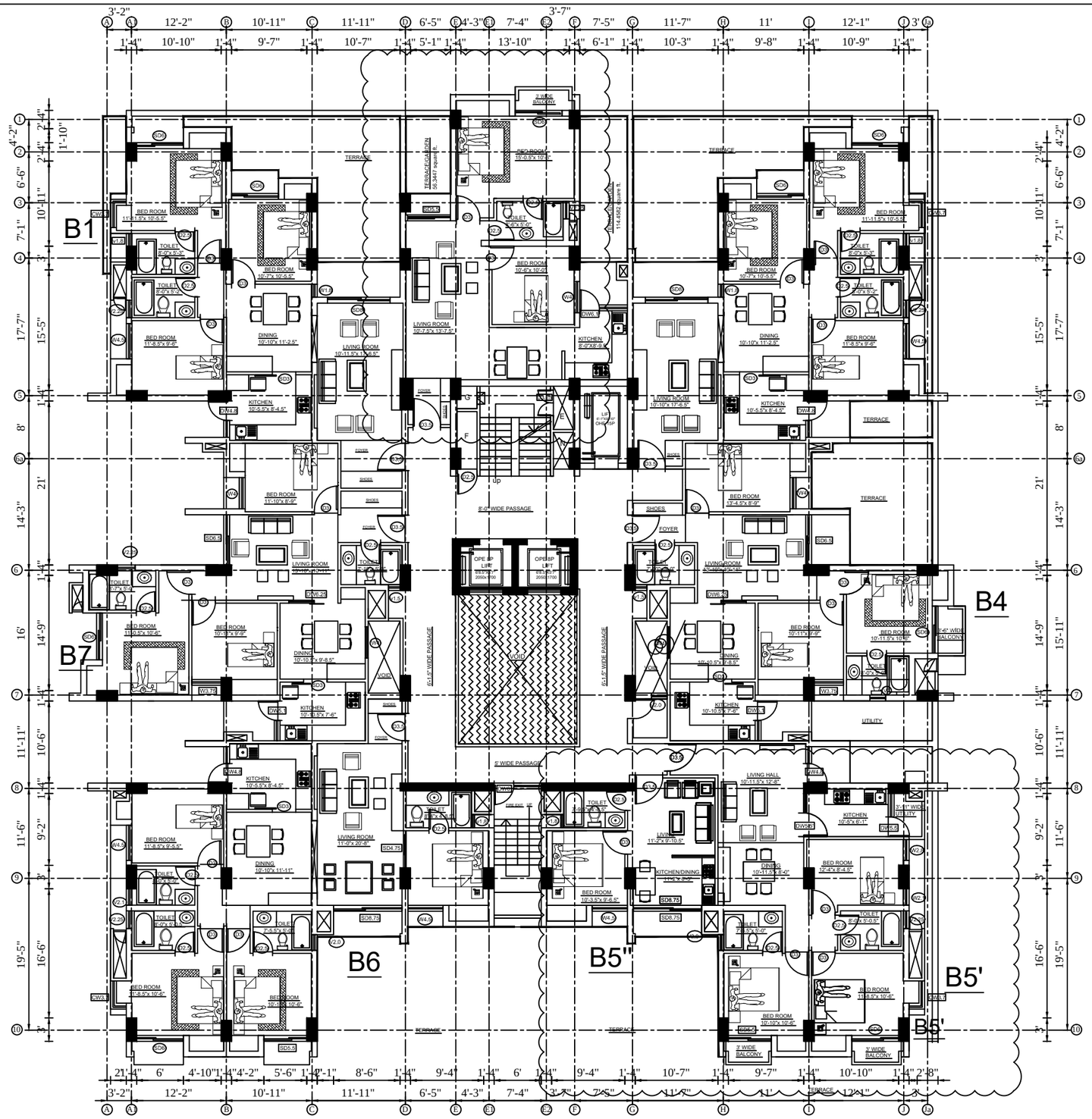
FIRST FLIGHT

STAIRCASE REINFORCEMENT DETAILS

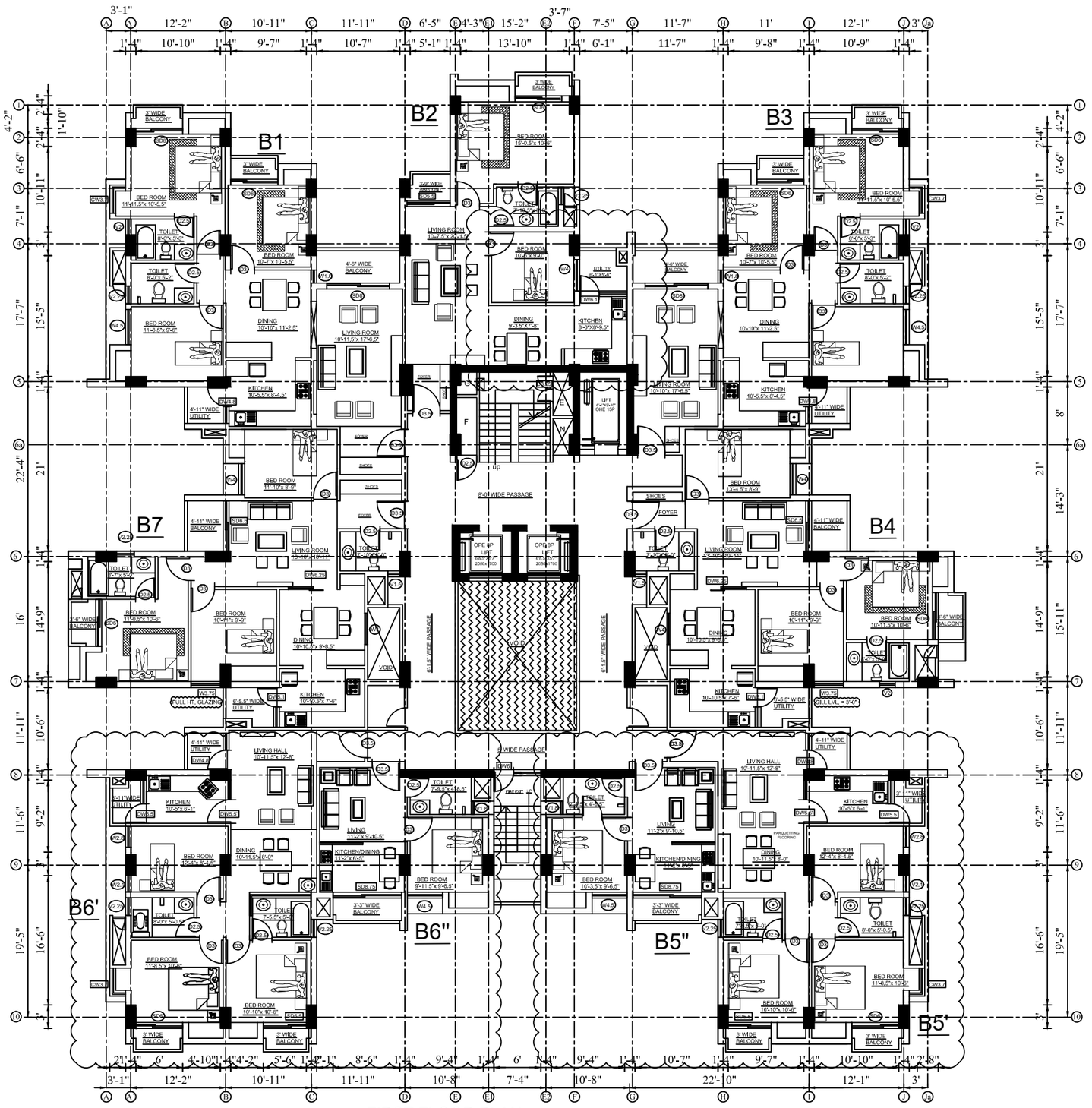
Slab Thickness = 150mm
Riser = 150mm
Tread = 300mm

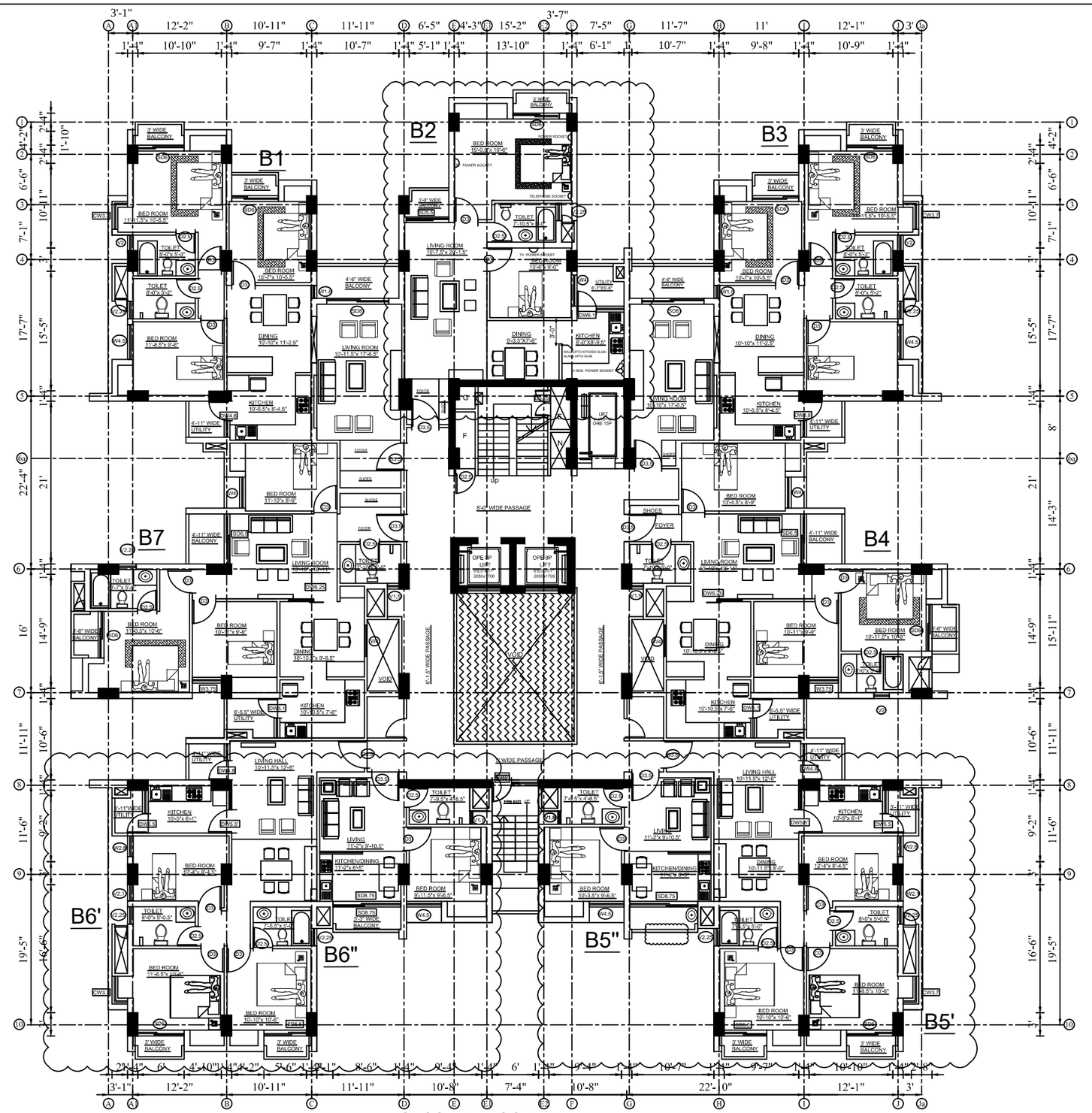
Scale 1:100

REINFORCED CONCRETE FRAME
OF
HIGH RISE
BY
ENGINEERED CONSTRUCTION
AT
DHAPAKHEL, LALITPUR, NEPAL



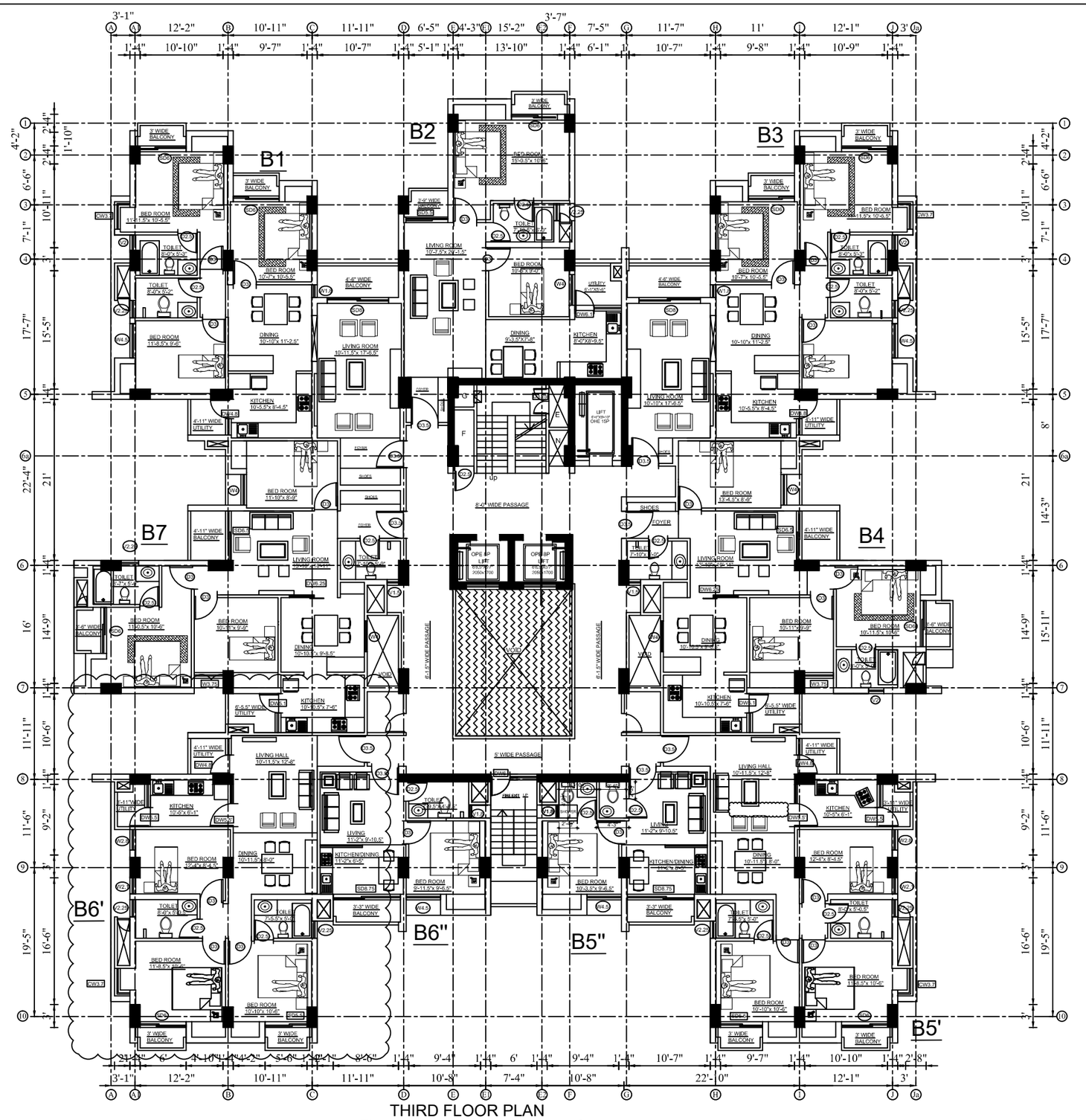
GROUND FLOOR PLAN
Plinth Area = 11127.06 square ft


B1
B2
B3
B4
B5
B5'
B5"
B6'
B6"
B7
N
3'-1"
12'-2"
10'-11"
11'-11"
6'-5"
4'-3"
15'-2"
3'-7"
7'-5"
11'-7"
11'
12'-1"
3' 1/8"
1'-4"
10'-10"
9'-7"
10'-7"
5'-1"
13'-10"
6'-1"
11'-7"
9'-8"
10'-9"
4'-2"
2'-4"
1'-10"
6'-6"
10'-11"
7'-1"
17'-7"
15'-5"
22'-4"
21'
16'
14'-9"
11'-11"
10'-6"
11'-6"
9'-2"
19'-5"
16'-6"
14'-3"
15'-11"
8'
3' WIDE BALCONY
4'-6" WIDE BALCONY
3'-3" WIDE BALCONY
4'-11" WIDE BALCONY
4'-11" WIDE UTILITY
6'-5.5" WIDE UTILITY
BED ROOM
TOILET
LIVING ROOM
DINING
KITCHEN
KITCHEN/DINING
LIVING HALL
LIVING
FOYER
SHOES
VOID
LIFT
8'-0" WIDE PASSAGE
6'-5.5" WIDE PASSAGE
FULL HT. GLAZING
TARQUETTING FLOORING
FIRST FLOOR PLAN
Floor Area = 10505.13 square ft
2 of 23
Scale 1:250



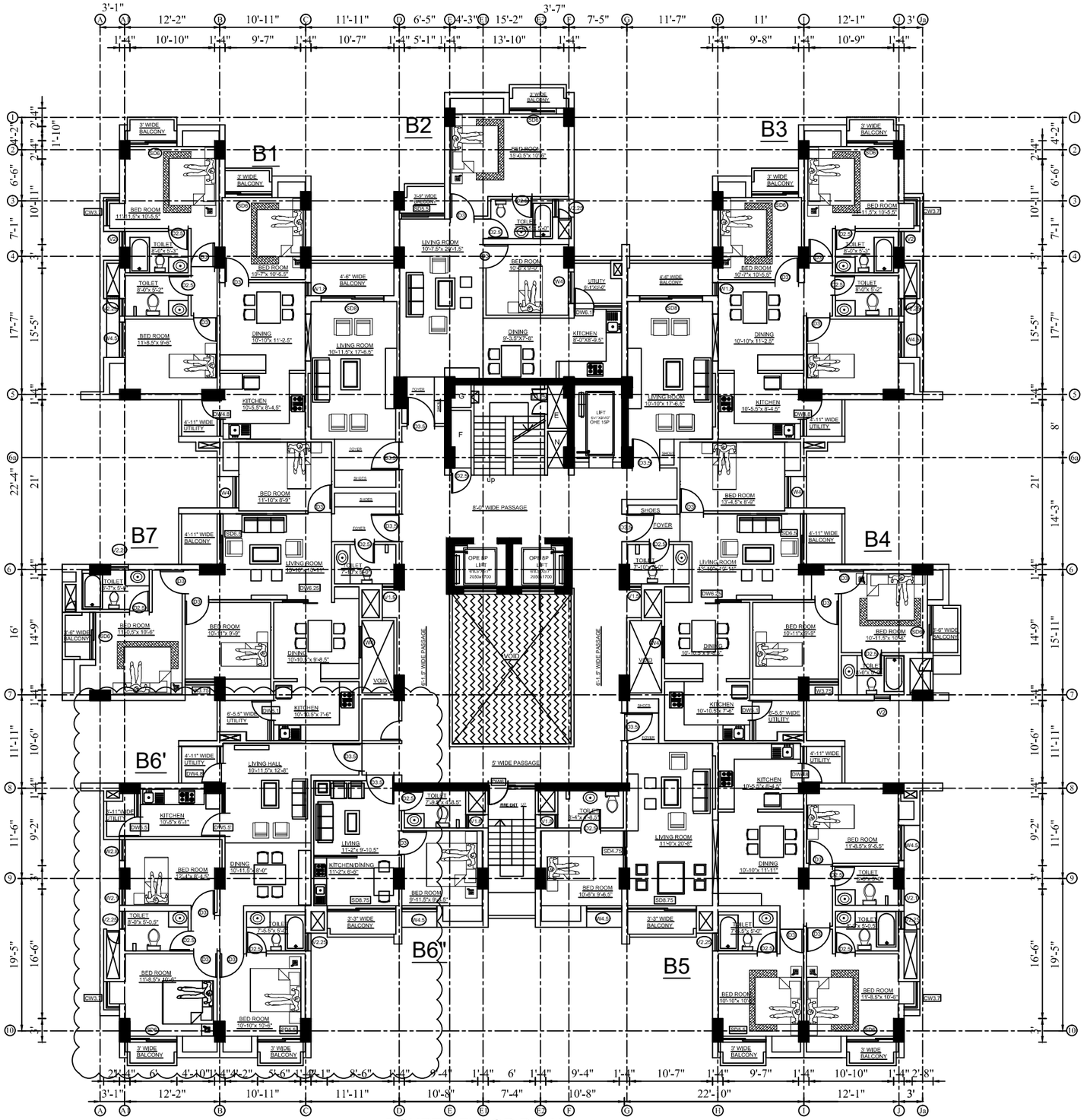
SECOND FLOOR PLAN
Floor Area = 10383.12 square ft

Scale 1:250



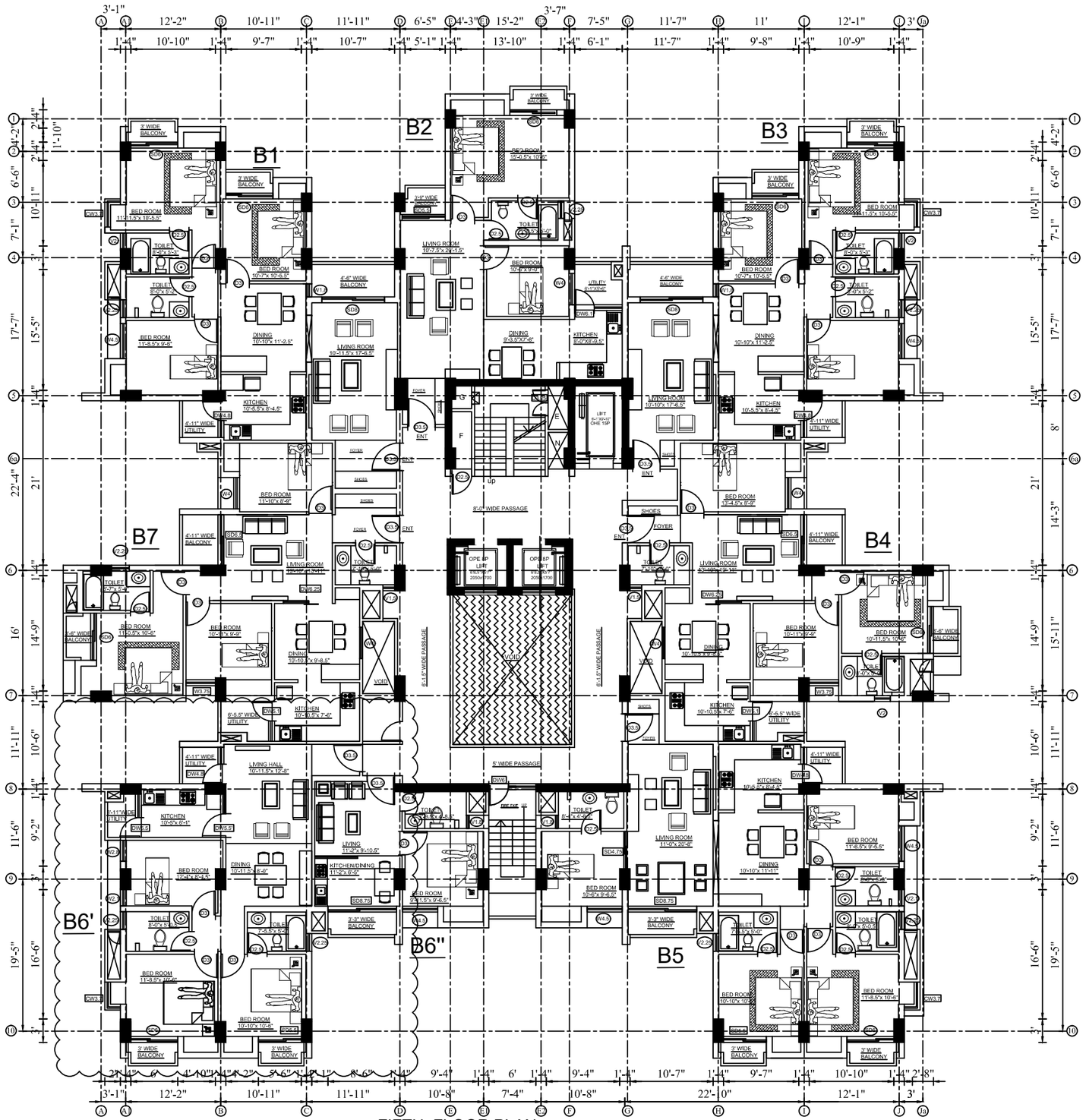
THIRD FLOOR PLAN
Floor Area = 10364.51 square ft

Scale 1:250



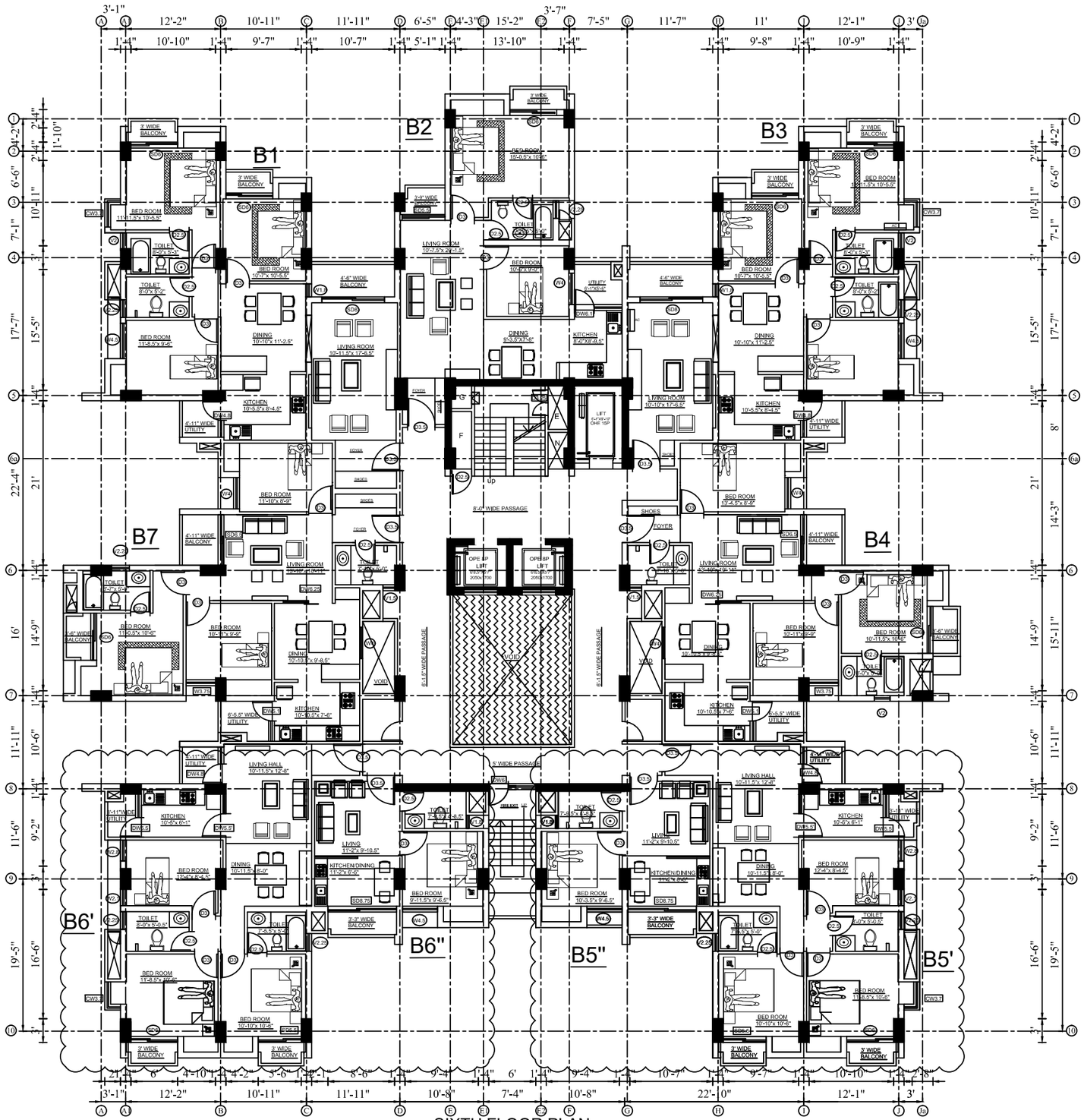
FOURTH FLOOR PLAN
Floor Area = 10354.65 square ft

Scale 1:250



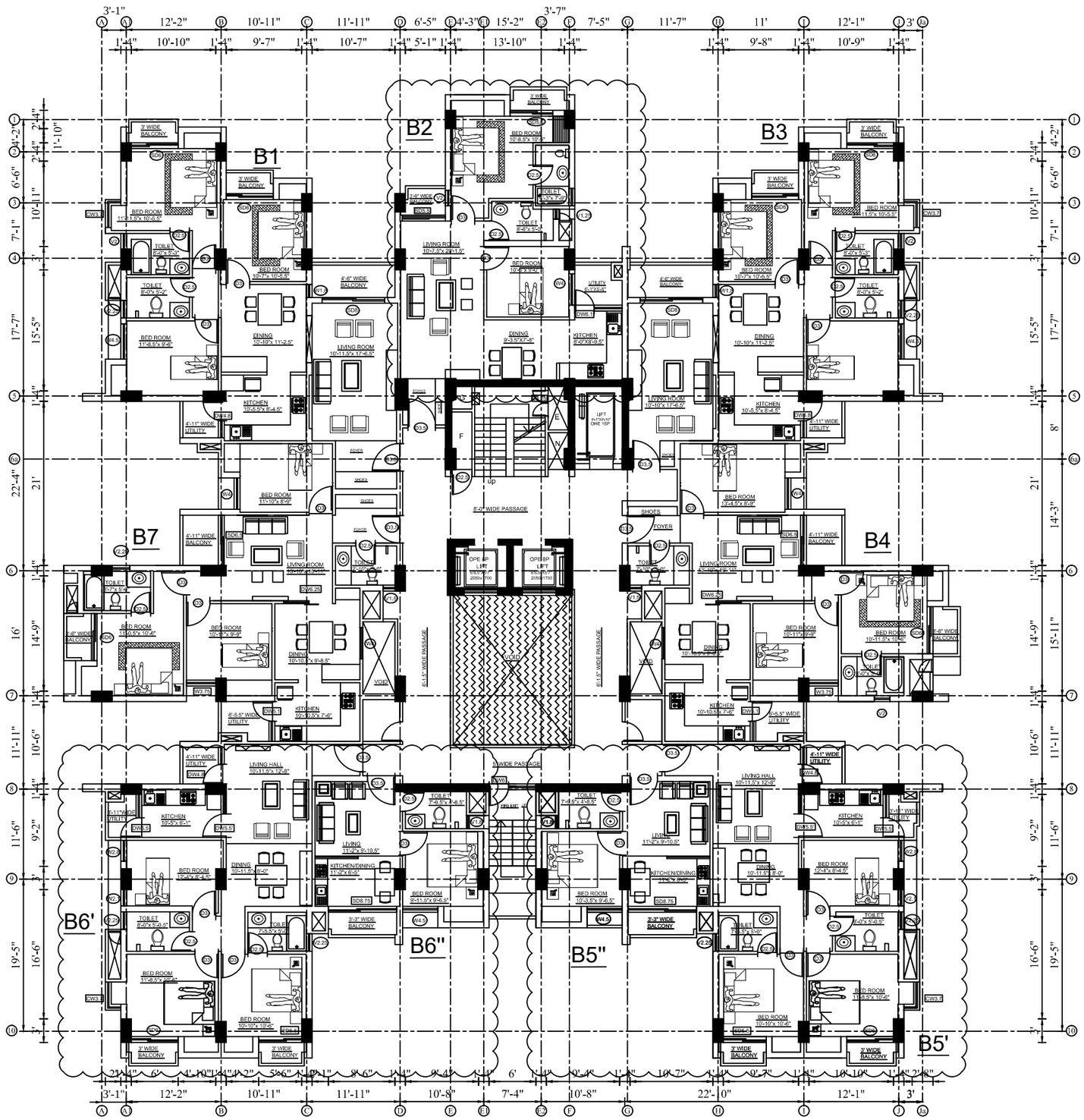
FIFTH FLOOR PLAN
Floor Area = 10365.46 square ft

Scale 1:250



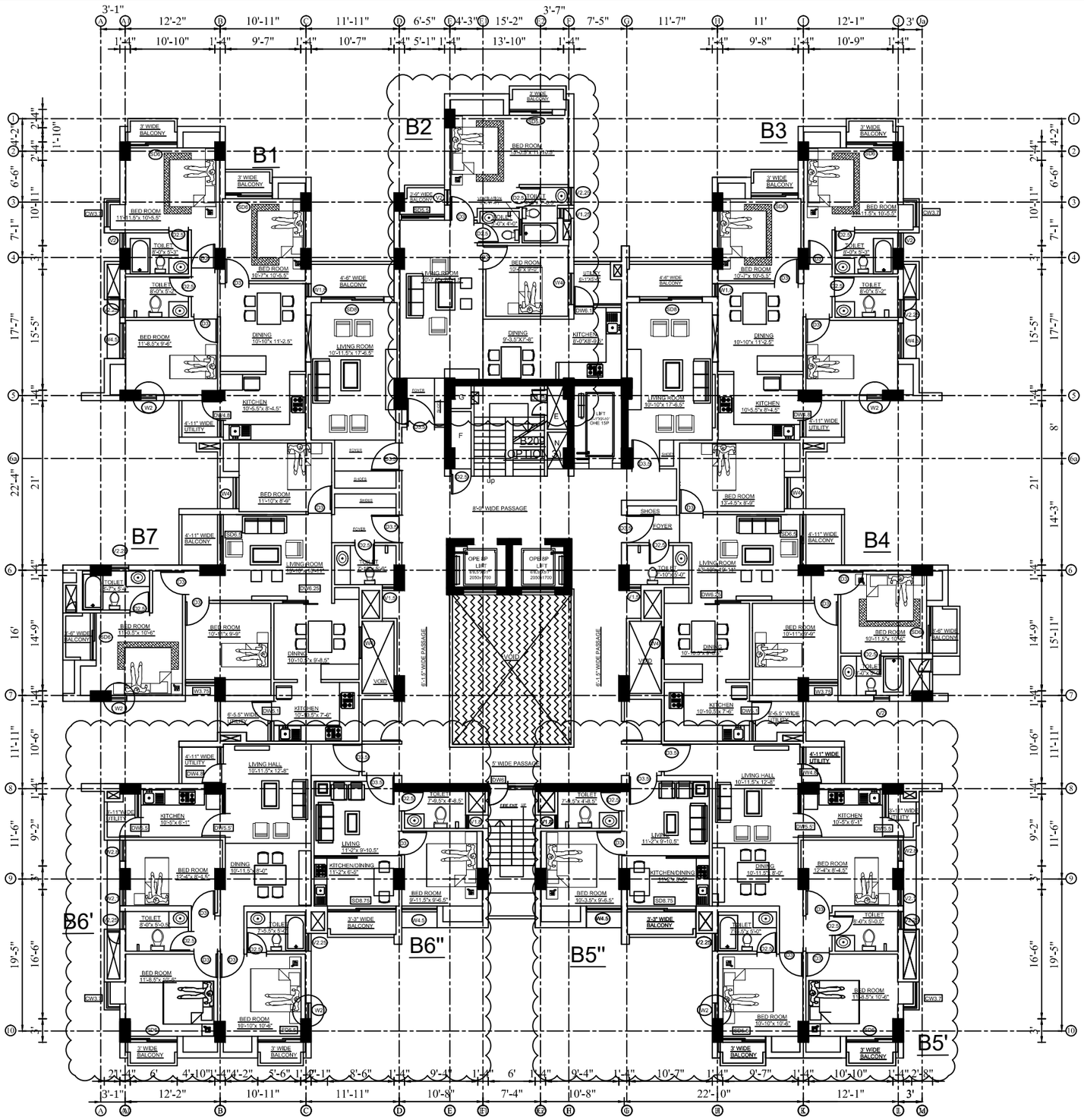
SIXTH FLOOR PLAN
Floor Area = 10464.83 square ft

Scale 1:250

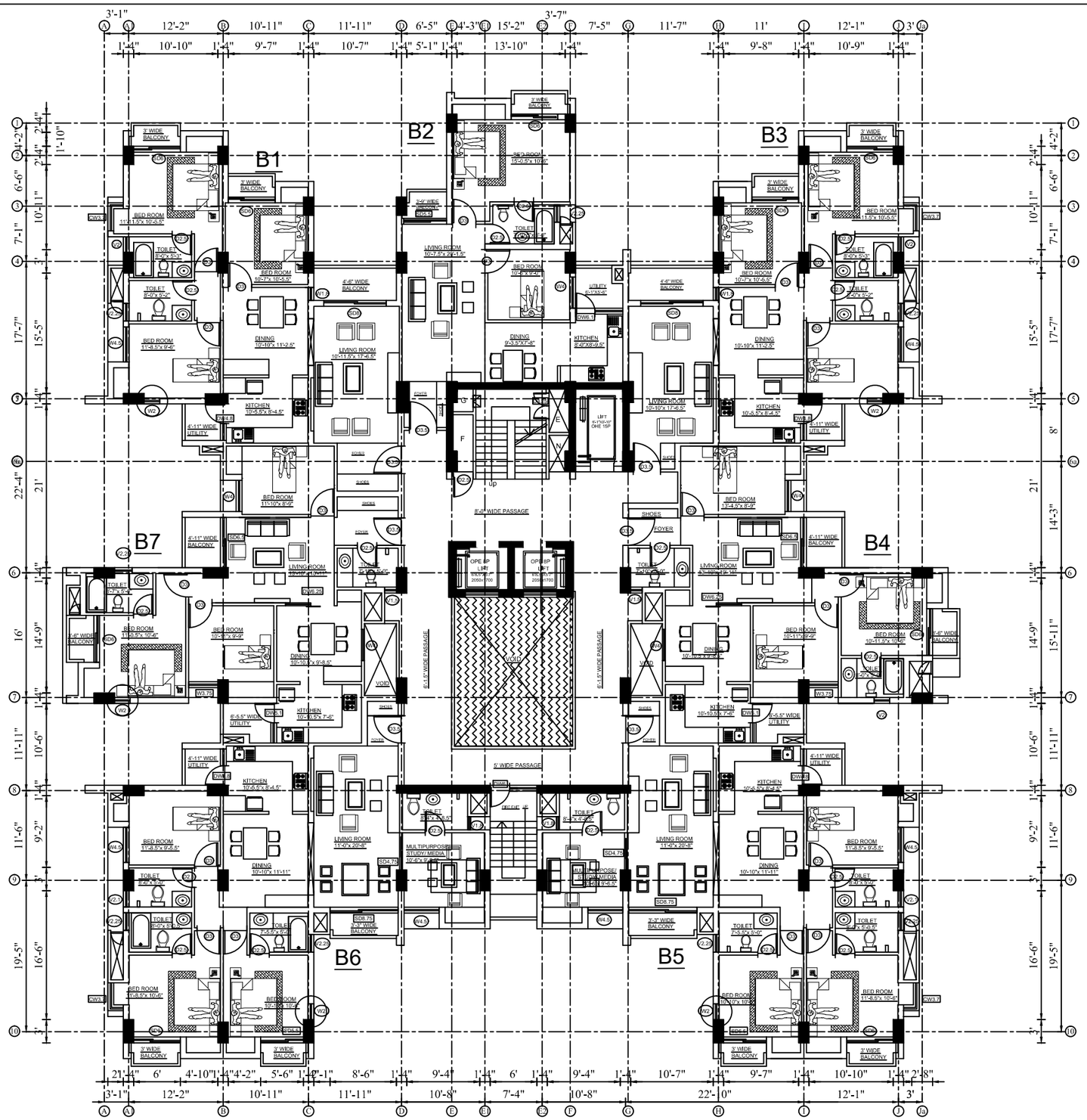


SEVENTH FLOOR PLAN
Floor Area = 10338.70 square ft

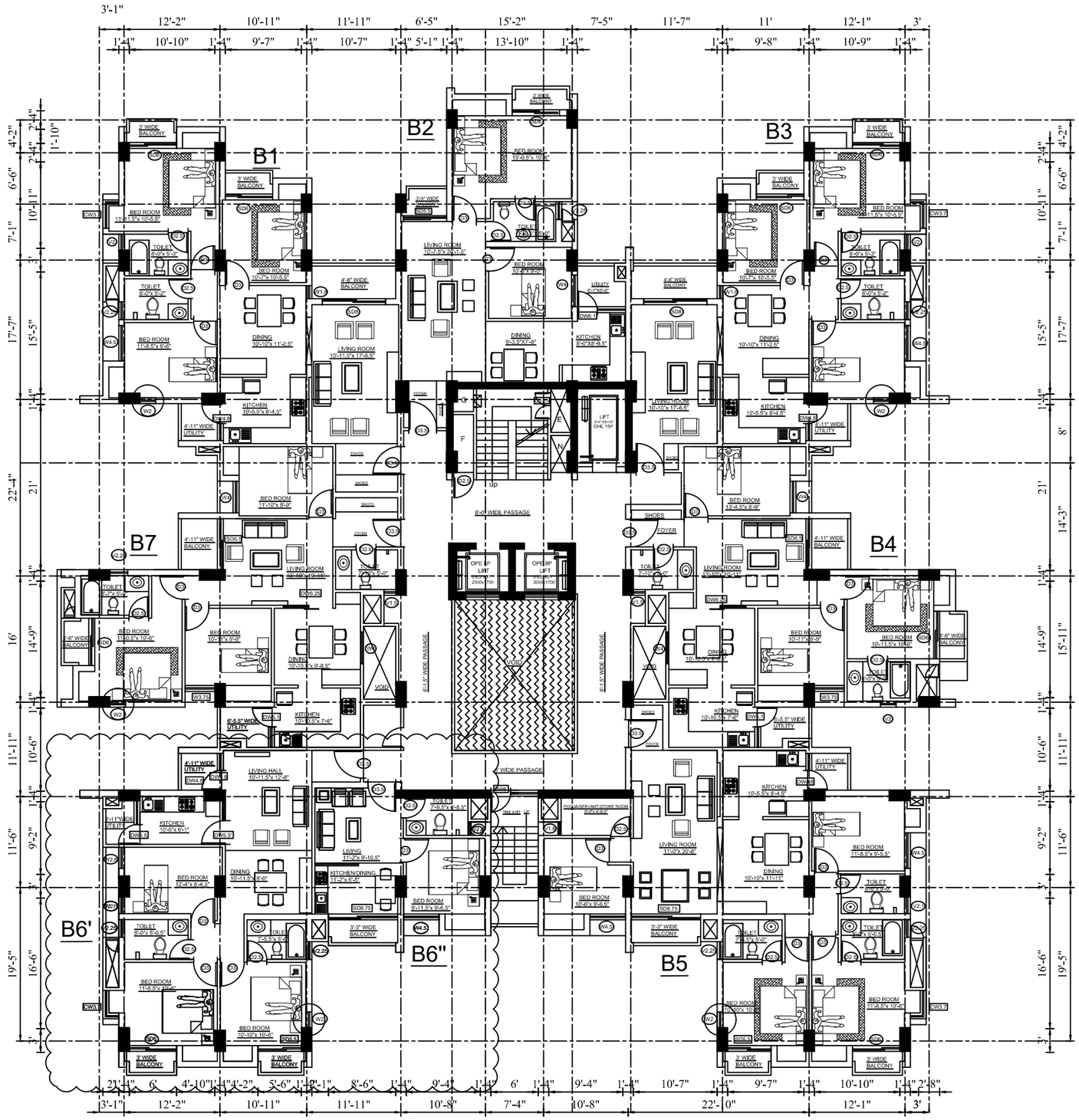
Scale 1:250



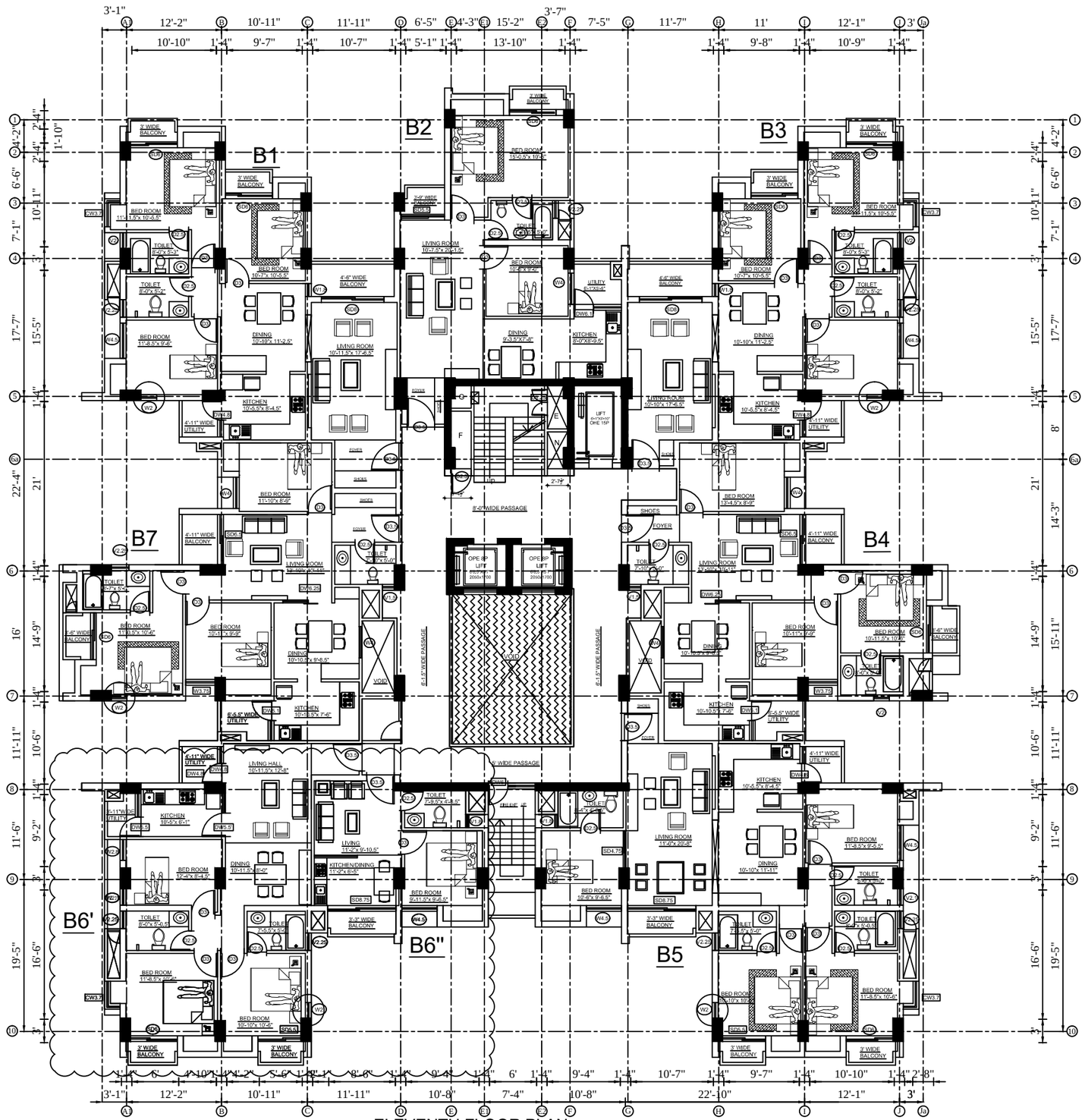
EIGHTH FLOOR PLAN
Floor Area = 10339.53 square ft



NINTH FLOOR PLAN
Floor Area = 10351.04 square ft

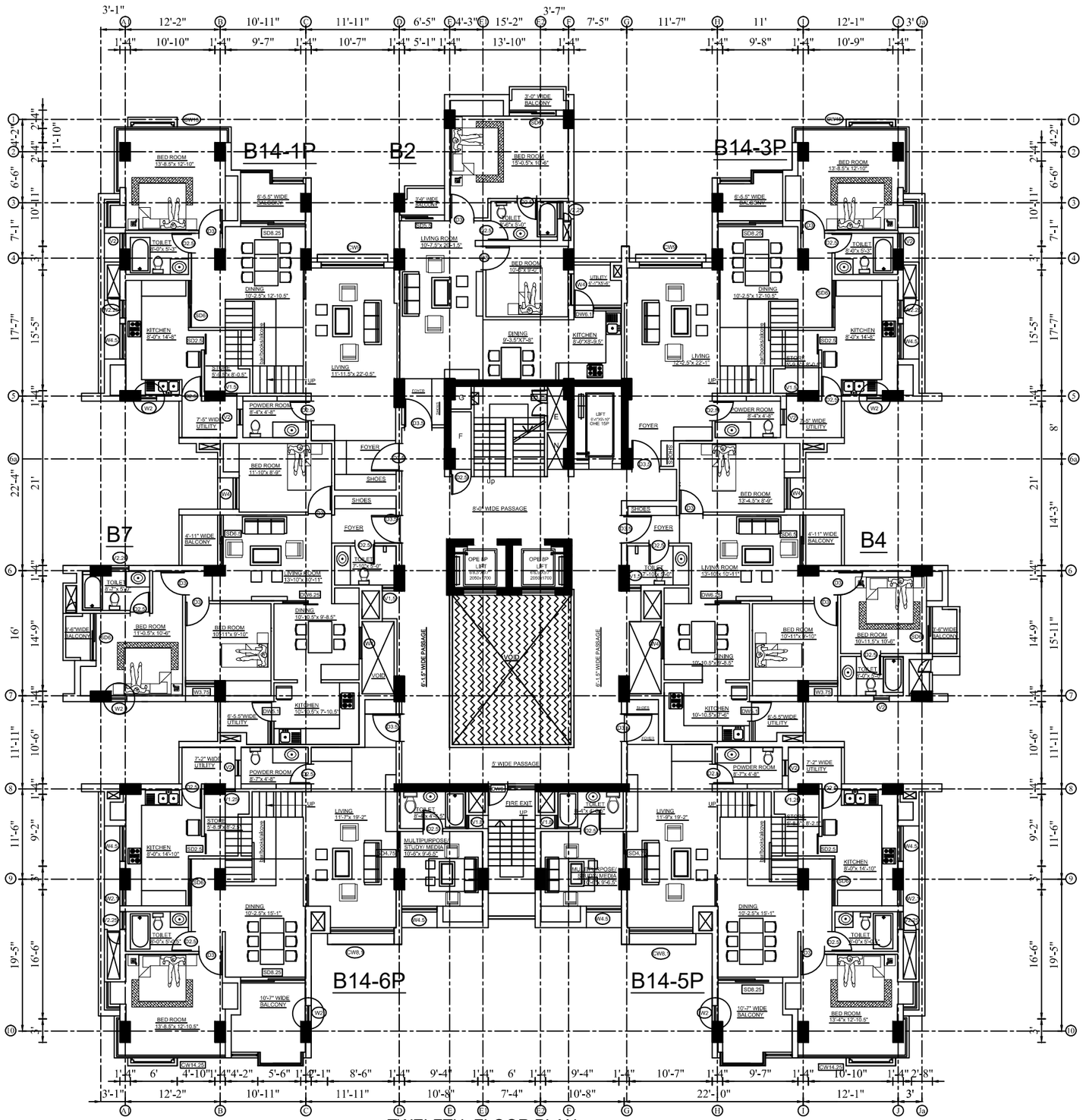


TENTH FLOOR PLAN
Floor Area = 10352.54 square ft



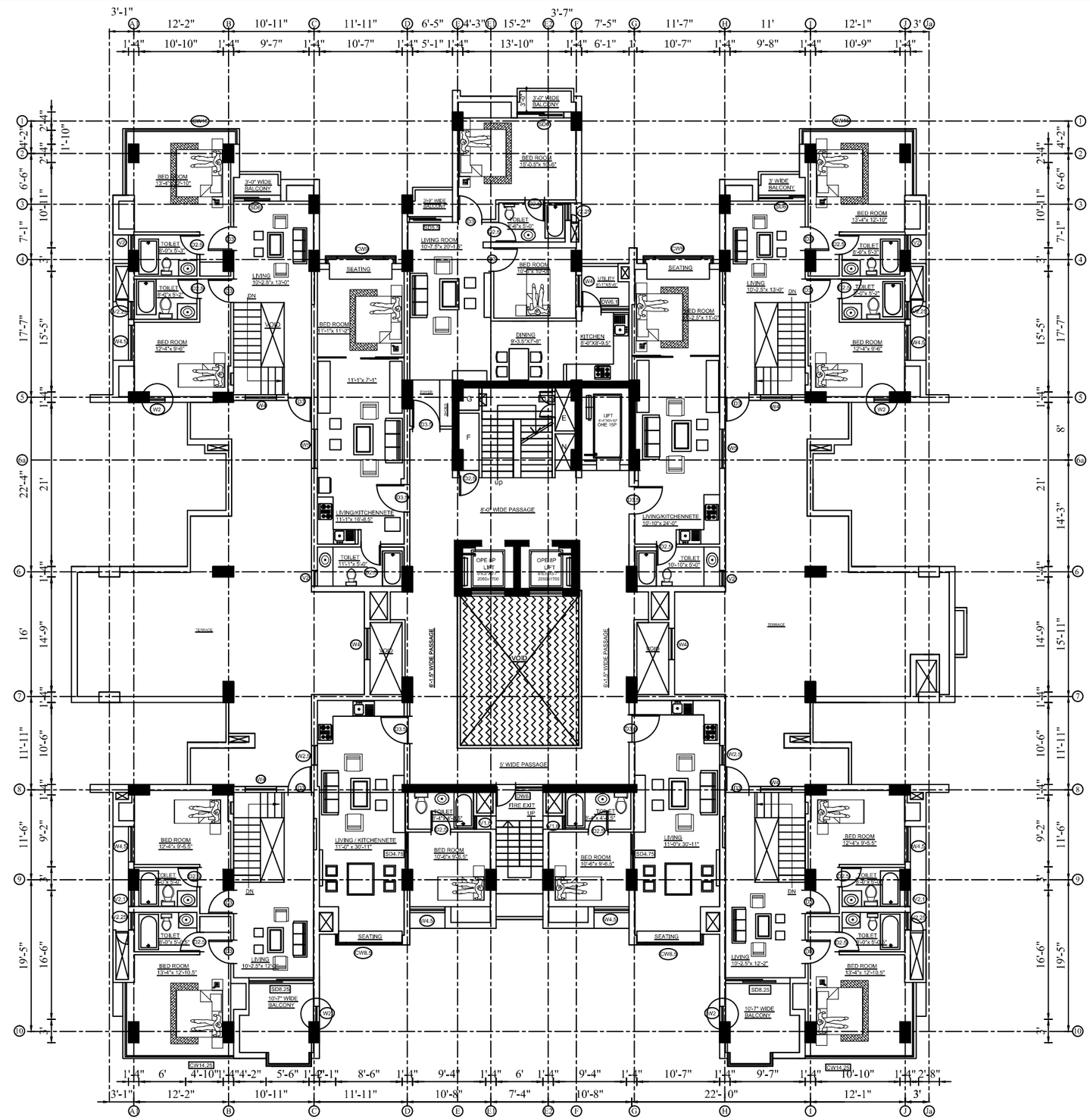
ELEVENTH FLOOR PLAN
Floor Area = 10352.54 square ft

Scale 1:250



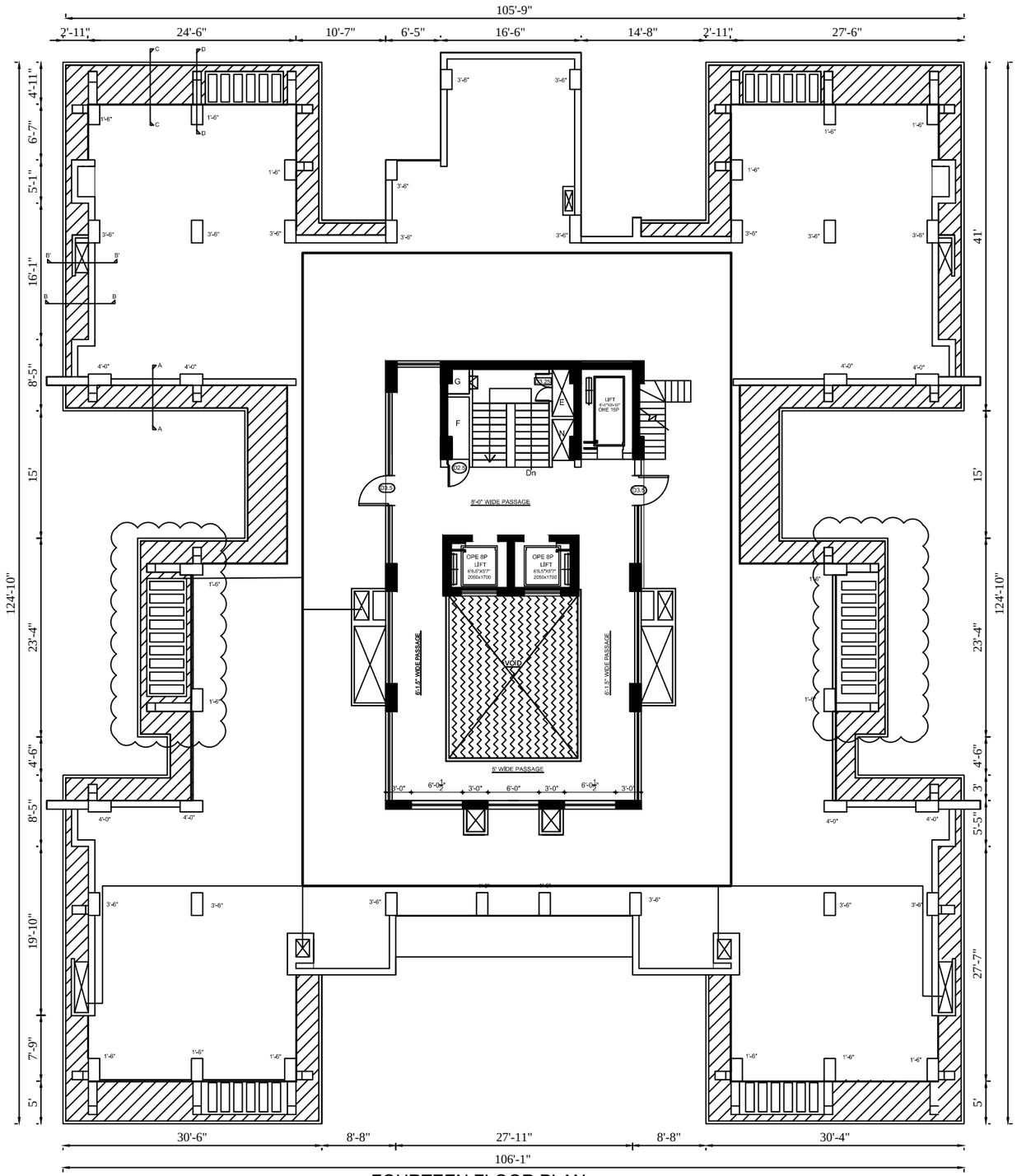
TWELFTH FLOOR PLAN
Floor Area = 10506.67 square ft

Scale 1:250



THIRTEEN FLOOR PLAN
Floor Area = 10458.08 square ft

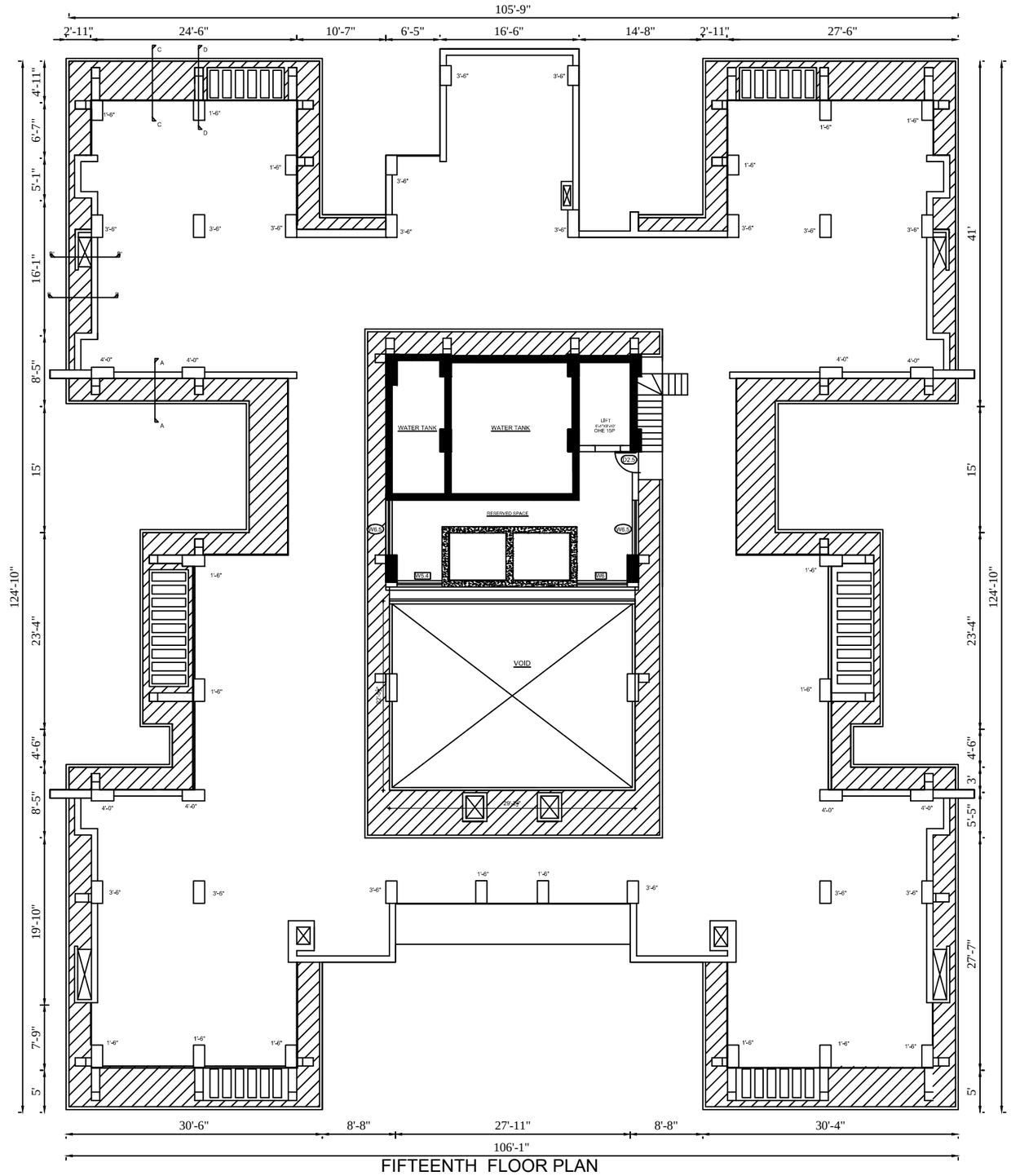
Scale 1:250



FOURTEEN FLOOR PLAN
Floor Area = 8276.22 square ft

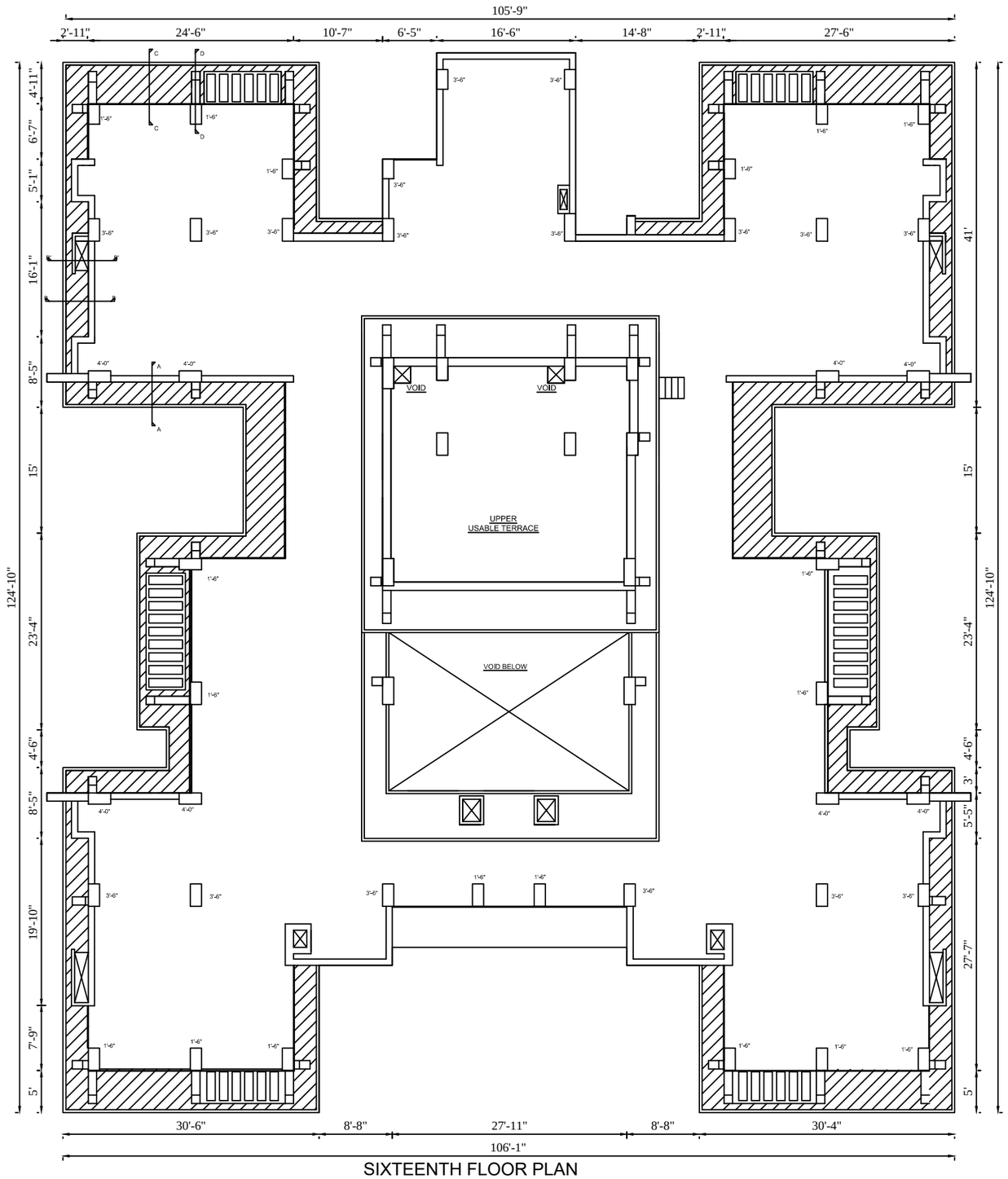
N

Scale 1:250



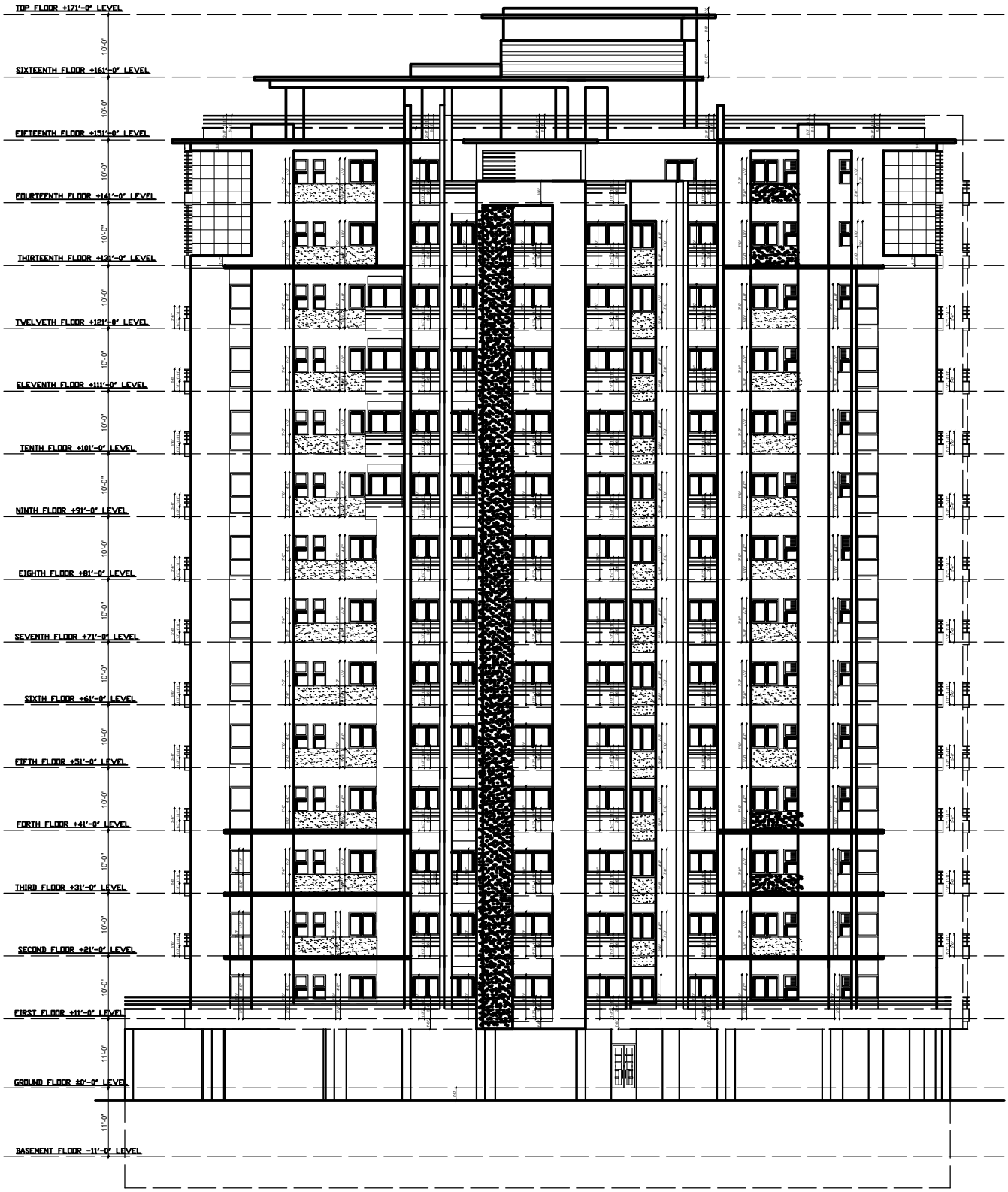
FIFTEENTH FLOOR PLAN

Scale 1:250



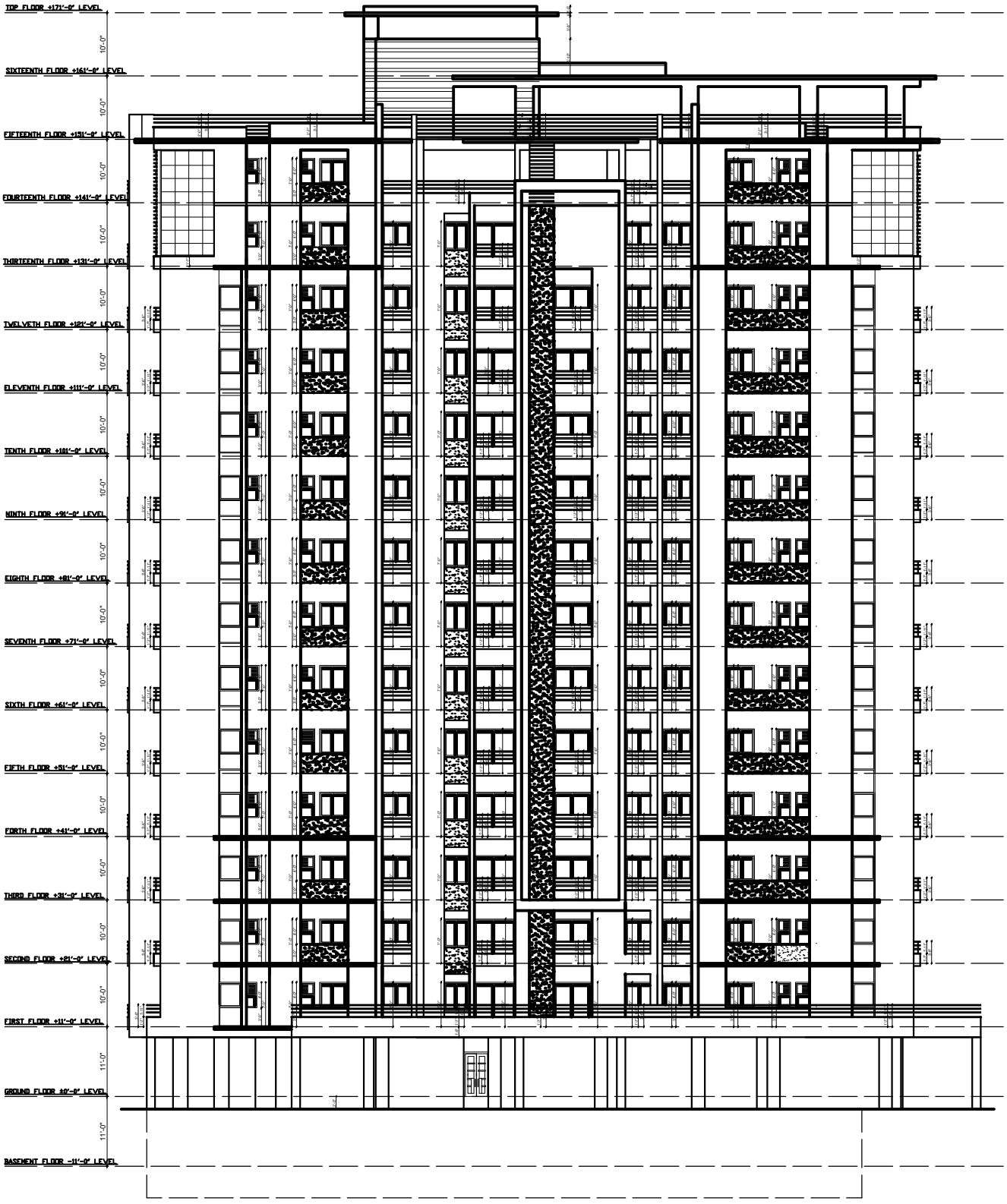
SIXTEENTH FLOOR PLAN

Scale 1:250



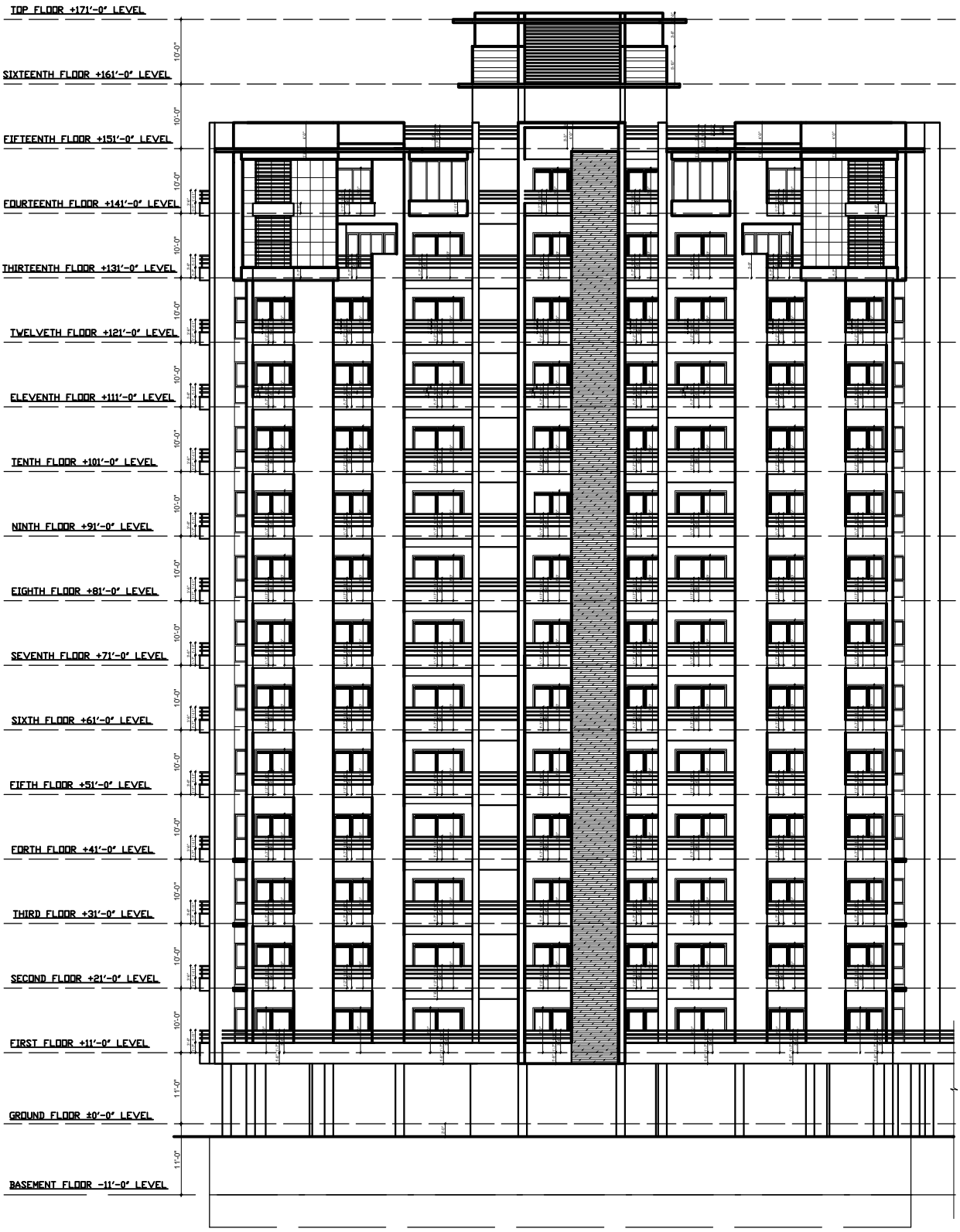
EAST ELEVATION (BLOCK B)

Scale 1:300

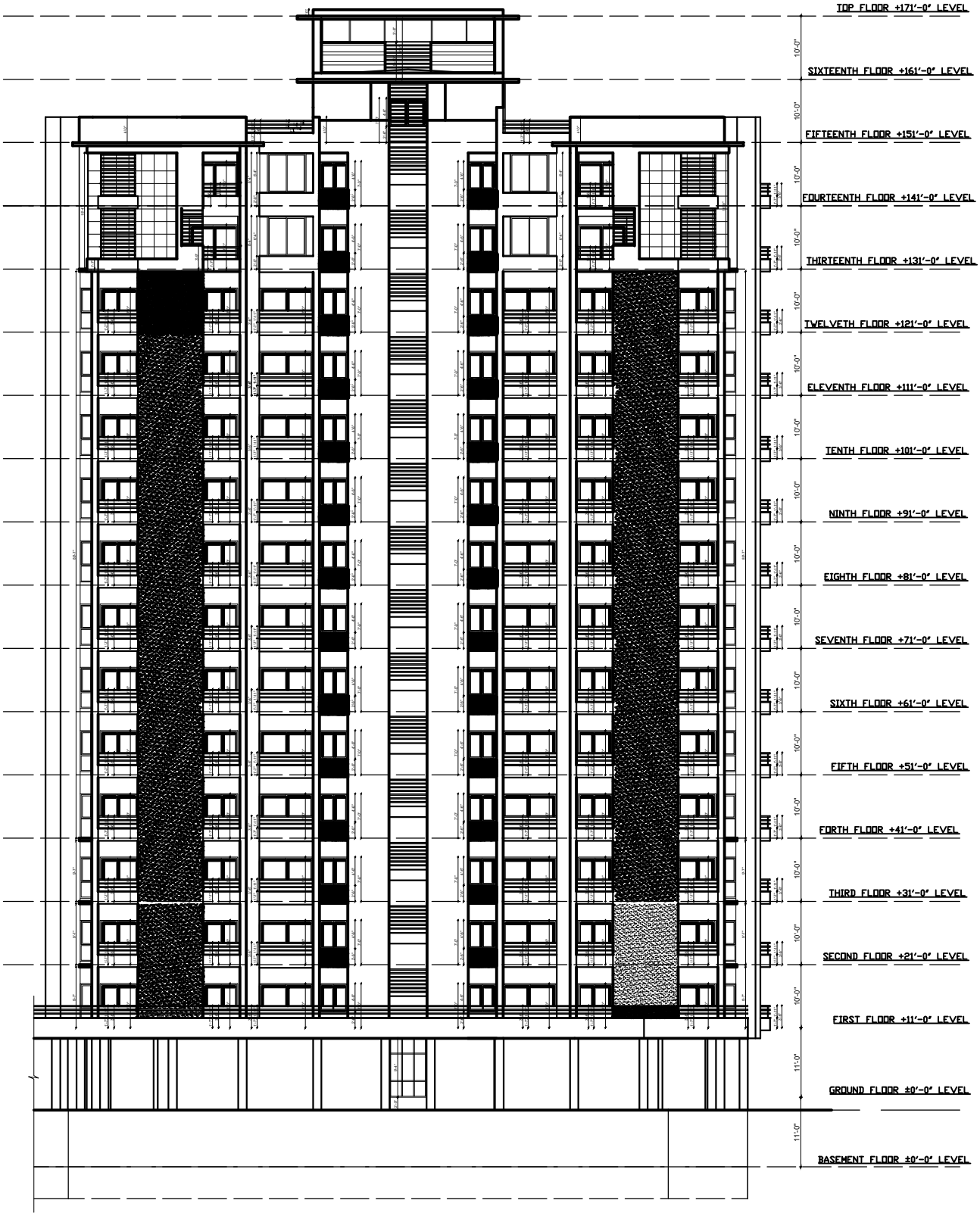


WEST ELEVATION(BLOCK B)

Scale 1:300

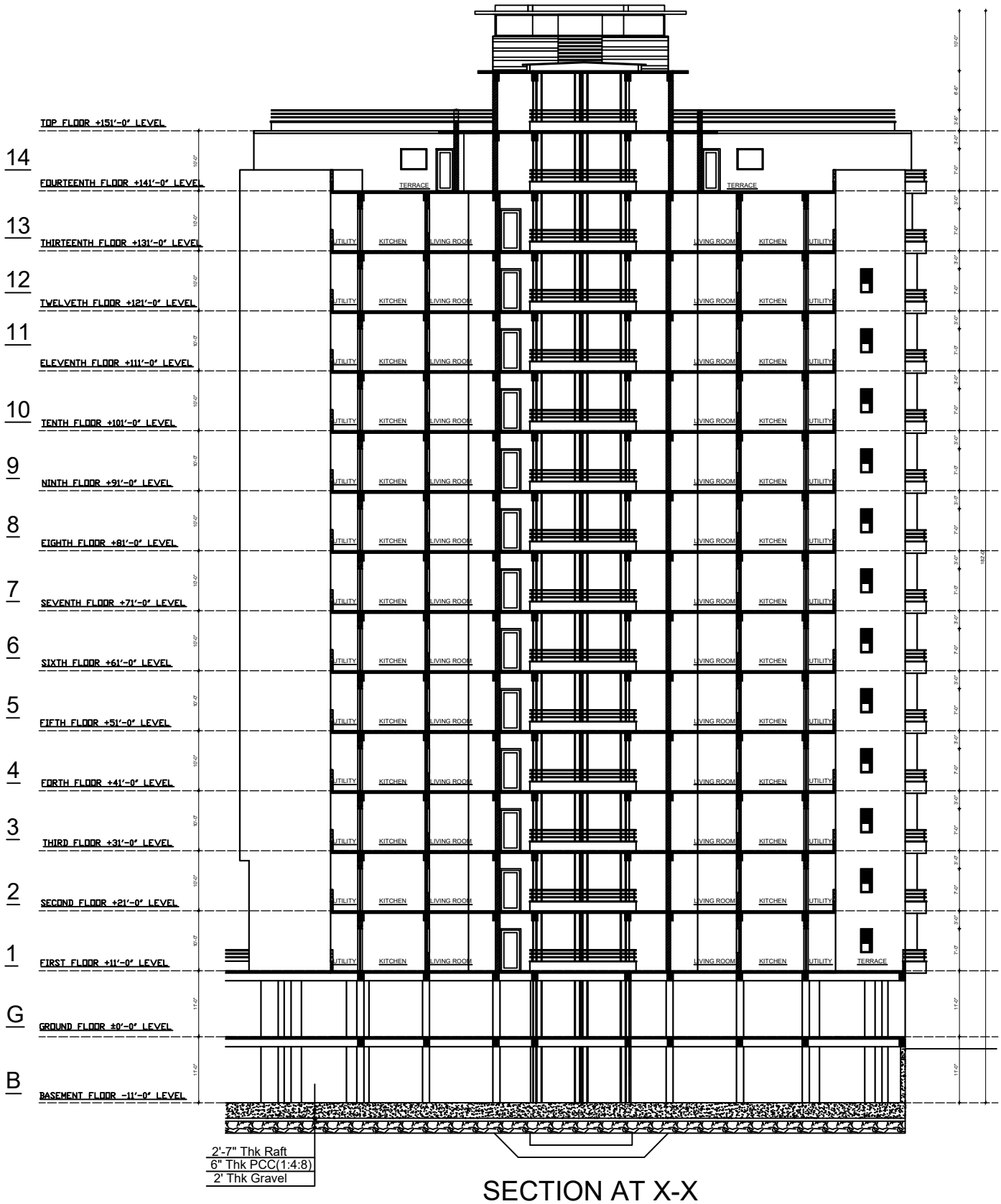


NORTH ELEVATION



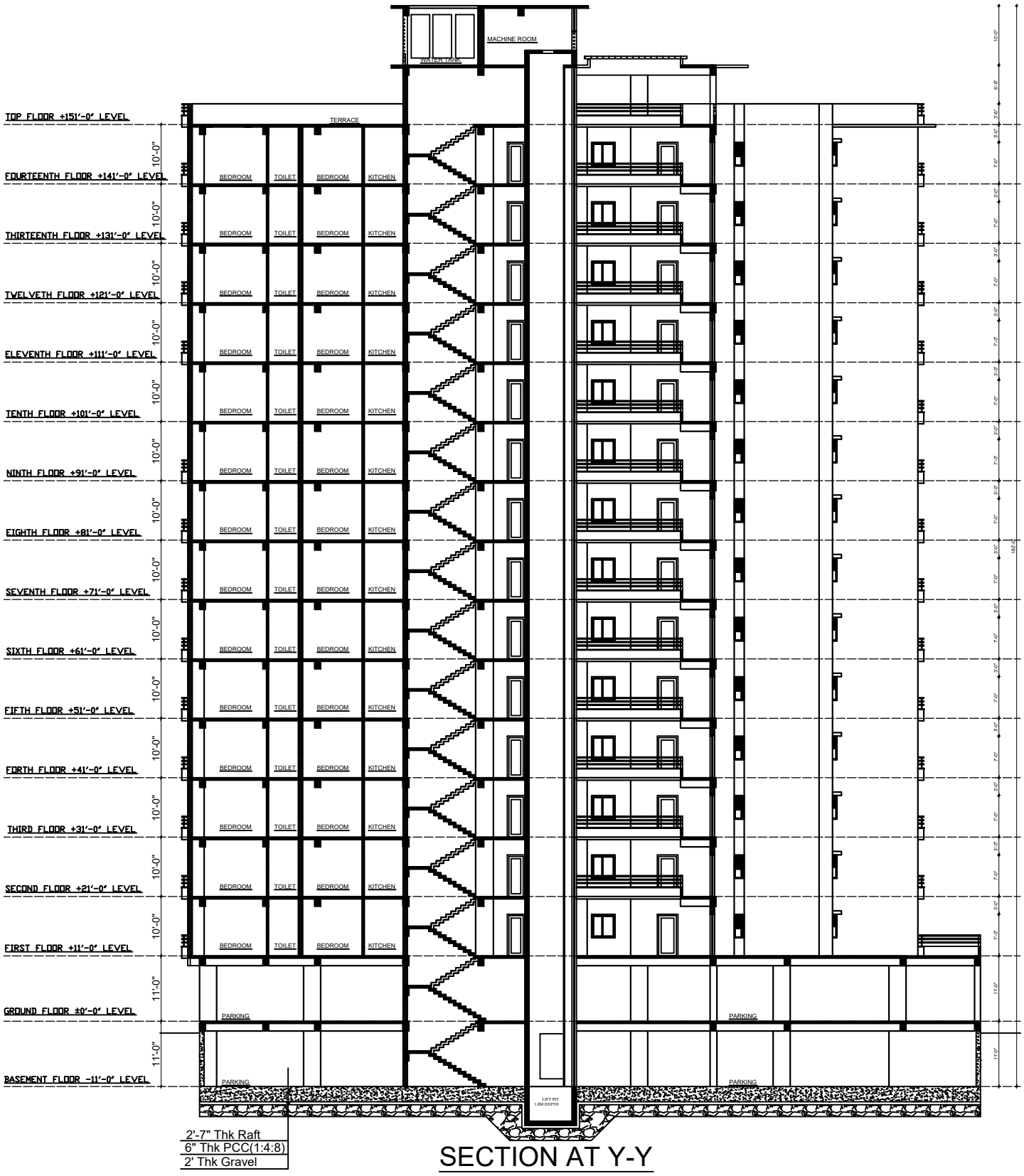
SOUTH ELEVATION

Scale 1:300



SECTION AT X-X

Scale 1:300



SECTION AT Y-Y

Scale 1:300

STRUCTURE DRAWINGS

OF

REINFORCED CONCRETE FRAME

OF

HIGH RISE

BY

ENGINEERED CONSTRUCTION

AT

DHAPAKHEL, LALITPUR, NEPAL