NEPAL NATIONAL BUILDING CODE

DRAFT FINAL NBC 205: 2012

READY TO USE GUIDELINE FOR DETAILINGS OF LOW RISE REINFORCED CONCRETE BUILDINGS WITHOUT MASONRY INFILL

Government of Nepal
Ministry of Urban Development
Department of Urban Development and Building Construction
Babar Mahal, Kathmandu, NEPAL
2070

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This publication represents a standard of good practice and therefore takes the form of recommendations. Compliance with it does not confer immunity from relevant legal requirements, including bylaws

नेपाल सरकार (मन्त्रिपरिषद्) को मिति को निर्णयानुसार स्वीकृत

Government of Nepal
Ministry of Urban Development
Department of Urban Development and Building Construction
Babar Mahal, Kathmandu, NEPAL

Preface to the first edition

This Nepal Standard was prepared during 1993 as part of a project to prepare a draft National Building Code for Nepal.

In 1988 the Ministry of Housing and Physical Planning (MHPP), conscious of the growing needs of Nepal's urban and shelter sectors, requested technical assistance from the United Nations Development Programme and their executing agency, United Nations Centre for Human Settlements (UNCHS).

A programme of Policy and Technical Support was set up within the Ministry (UNDP Project NEP/88/054) and a number of activities have been undertaken within this framework.

The 1988 earthquake in Nepal, and the resulting deaths and damage to both housing and schools, again drew attention to the need for changes and improvement in current building construction and design methods.

Until now, Nepal has not had any regulations or documents of its own setting out either requirements or good practice for achieving satisfactory strength in buildings.

In late 1991 the MHPP and UNCHS requested proposals for the development of such regulations and documents from international organizations in response to terms of reference prepared by a panel of experts.

This document has been prepared by the subcontractor's team working within the Department of Building, the team including members of the Department and the MHPP. As part of the proposed management and implementation strategy, it has been prepared so as to conform with the general presentation requirements of the Nepal Bureau of Standards and Metrology.

The subproject has been undertaken under the aegis of an Advisory Panel to the MHPP.

The Advisory Panel consisted of :

Mr. UB Malla, Joint Secretary, MHPP	Chairma
n Director General, Department of Building (Mr. LR Upadhyay)	Member
Mr. AR Pant, Under Secretary, MHPP	Membe
r Director General, Department of Mines & Geology (Mr. PL Shrestha)	Member
Director General, Nepal Bureau of Standards & Metrology (Mr. PB Manandhar)	Member
Dean, Institute of Engineering, Tribhuvan University (Dr. SB Mathe)	Member
Project Chief, Earthquake Areas Rehabilitation & Reconstruction Project	Member
President, Nepal Engineers Association	Member
Law Officer, MHPP (Mr. RB Dange)	Member
Representative, Society of Consulting Architectural &	

Engineering Firms (SCAEF)	Member
Representative, Society of Nepalese Architects (SONA)	Member
Deputy Director General, Department of Building, (Mr. JP Pradhan)	Member-Secretary

The Subcontractor was BECA WORLEY INTERNATIONAL CONSULTANTS LTD. of New Zealand in conjunction with subconsultants who included:

Golder Associates Ltd., Canada
SILT Consultants P. Ltd., Nepal
TAEC Consult (P.) Ltd., Nepal
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Preface to the second edition

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……..

Should be written by DUDBC

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0. Foreword

0. 1 Introduction

For the last 30 to 35 years there has been a proliferation of reinforced concrete (RC) framed buildings constructed in the urban and semi-urban areas of Nepal. Most of these buildings have been built on the advice of mid-level technicians and masons without any professional structural design input. These buildings have been found to be significantly vulnerable to a level of earthquake shaking that has a reasonable chance of happening in Nepal. Hence, these buildings, even though built with modern materials, could be a major cause of loss of life in future earthquakes. Upgrading the structural quality of future buildings of this type is essential in order to minimise the possible loss of life due to their structural failure.

0. 2 Objective

The main objective of these Ready to Use Detailing Guideline (RUD) is to provide ready-to-use dimensions and details for various structural and non-structural elements for up to three-storey reinforced concrete (RC), framed, ordinary residential buildings commonly being built by owner-builders in Nepal.

This RUD is intended to cater primarily to the requirements of mid-level technicians (overseers and draughtspersons) who are not trained to undertake independently the structural design of buildings. However Engineers can also use it for reference and cross check their design output.

0.3 Limitations

The requirements set forth in this guideline shall be applicable for ordinary buildings as per clause 4.0. The intention is to achieve a minimum acceptable structural safety, even though it is always preferable to undertake specific investigations and design.

Owners and builders must use the services of competent professional designers for buildings not covered by these guidelines.

1 Scope

1.1 General

1.1.1 This RUD Guideline addresses the particular requirements of those RC-framed buildings which have become very common with owner-builders, who even undertake the construction of this type of buildings without employing professional designers. However, the users of this RUD are required to comply with certain restrictions with respect to building configuration, layout and overall height and size.

1.1.2 The RUD Guideline is intended for buildings of the regular column-beam type with reinforced concrete slabs for floors and the roof. The walls are assumed to be of burnt bricks, or hollow concrete or other rectangular blocks whose density will not exceed that of burnt bricks. Here, all the calculations are based on solid clay burnt bricks. These can be replaced by the above described blocks. The buildings have to comply with certain limitations listed in **Clause 4.1, 4.2.**

1.1.3 The RUD Guideline presents ready-to-use designs for all structural components, including detailing of structural as well as non-structural members for the specified building type.

1.1.4 Proportioning of structural components represented in RUD Guideline is for ordinary residential buildings located in most severe seismic zone

1.1.5 The building could, of course, be alternatively designed using the usual design standards for engineered structures. The design procedures here are simplified in order both to save design time and to help owner-builders to adopt the recommended design and details so that they will achieve earthquake-resistant structures.

1.2 Related Standards

The requirements of this RUD Guideline are based on the following standards, codes and documents. Compliance with this RUD Guideline will, therefore, result in compliance with these Standards:

i) IS 456-2000 : (Plain and Reinforced Cement Concrete)

ii) S.P. 16 –1980: Design Aids for Reinforced Concrete to IS: 456-2000.

iii) NBC 102:1994 (Unit Weight of materials) / NBC 103:1994 (Occupancy load);

i)

iv) NBC 105: 1994 (Seismic Design of Building in Nepal)

v) IS 13920-1993: (Ductile detailing of Reinforced Concrete Structures Subjected to Seismic Force)

2 Interpretation

2.1 General

2.1.1 In this RUD Guideline, the word `shall' indicates a requirement that is to be adopted in order to comply with the provision of this guideline, while the word `should' indicates recommended practice.

2.1.2 References to `Code' indicate Seismic Design of Buildings in Nepal (NBC 105:1994, ,NBC110:1994).

2.1.3 Words implying the singular only also include the plural and vice versa where the context requires this.

2.2 Terminology

2.2.0. In this Standard, unless inconsistent with the context, the following definitions shall apply:

2.2.1. THROUGH BARS means the bars that shall run continually parallel to the walls of a beam to form a cage. The minimum number of through bars in a beam shall not be less than 4.0.

2.2.2. EXTRA BARS means the longitudinal bars that shall be provided in addition to through bars at supports as top bars and bottom bars and at mid-span as bottom bars of a beam.

2.2.3. CHAIR means an element made of steel bar which is used to maintain the vertical distances between top and bottom bars in slabs.

2.2.4. DEAD LOAD means the weight of all permanent components of a building including walls, partitions, columns, beams, floors, roofs, finishes and fixed plant and fittings that are an integral part of the structure.

2.2.5. DESIGN means use of rational computational or experimental methods in accordance with the established principles of structural mechanics.

2.2.6. FRAME means a system composed of interconnected beams and column members functioning as a complete self-contained unit with or without the aid of horizontal diaphragms or floor-bracing systems.

2.2.7. IMPORTANT BUILDINGS means those buildings which either house facilities essential before and after a disaster (eg., hospitals, fire and police stations, communication centres, etc.), or which by their very purpose have to house large numbers of people at one time (eg., cinema halls, schools, convention centres, etc.), or which have special national and international importance (eg., palaces, etc.), or which house hazardous facilities (eg., toxic or explosive facilities, etc.).

2.2.8. LANDSLIDE means the downward and outward movement of slope-forming materials.

2.2.9. LIQUEFACTION means the phenomenon in which relatively loose, saturated sandy soils lose a large proportion of their strength under seismic shaking.

2.2.10. LEVEL OF LOCAL RESTRAINT means the level at which the ground motion of the earthquake is transmitted to the structure by interaction between the foundation materials and the foundation elements by friction and bearing.

2.2.11. LIVE LOAD means the load assumed or known to result from the occupancy or use of a building and includes the loads on floors, loads on roofs other than wind, loads on balustrades and loads from movable goods, machinery, and plant that are not an integral part of the structure and may be changed during the life of the building with a resultant change in floor or roof loading.

2.2.12. LUMPED MASS means the theoretical concentration of the mass of adjacent upper and lower half storeys at any floor level.

2.2.13. MASONRY INFILL WALL means any structural wall constructed in brick with cement sand mortar inside the frame and intended to carry horizontal load by equivalent compression strut action.

2.2.14. NON-LOAD BEARING WALL means any wall which is not intended to carry any significant external loads and which functions just as a cladding, partition wall or filler wall.

2.2.15. ORDINARY BUILDING means any building which does not lie on an important building category as per clause 2.2.7 (eg., residential, general commercial, ordinary offices, etc.).

2.2.16.

2.2.17. STOREY means the space between two adjacent floors or platforms.

2.3 Symbols

A	Maximum horizontal length of building
A_s	Area of steel bar
B	Maximum horizontal width of building
C_d	Design seismic coefficient
D	Lateral stiffness of column
f_{ck}	Characteristic compressive strength of concrete
F_i	Horizontal seismic force applied at level i
f_y	Characteristic strength of steel
h_i	Height of the level i above the lateral restraint imposed by ground
K_1, K_2	Plan length of structural wings
K	Steel grade Fe500 (high-strength, TMT)
K_c	Stiffness ratio of column (moment of inertial divided by its length)
l	Centre-to-centre span of beam
M	Steel grade Fe250 (mild steel)
RC	Reinforced cement concrete
t_e	Thickness at the edge of the pad foundation
t_m	Maximum thickness of the pad foundation
T	Steel grade Fe415 (high-strength, cold-worked)
V	Total horizontal seismic base shear
V_{ij}	Horizontal load carried by a column line j at level i
W_i	Proportion of the W_t at a particular level i
W_t	Total of the vertical dead loads and appropriate live loads above the level of lateral restraint provided by the ground
ϕ	Diameter of steel bar

3 Selection and Investigation of Site

3.1 General

This section sets out some of the requirements to be considered during site selection for the construction of buildings in order to minimise the risks to the buildings from primary geological as well as secondary seismic hazards such as fault rupture, landslides and liquefaction. A building shall not be constructed as per this guidelines if the proposed site is:

- Water-logged
- A rock-falling area
- A landslide-prone area
- A subsidence and/or fill area
- A river bed or swamp area

3.2 Use of Local Knowledge

It is a good practice during the construction of a building to examine the existing local knowledge and the history of the performance of existing buildings. This will assist in identifying whether there is any danger from inherent natural susceptibilities of the land to the processes of sliding, erosion, land subsidence and liquefaction during the past earthquakes or any other natural/geological processes likely to threaten the integrity of the building. The local practice of managing such hazards, if any, should be judged against the required level of acceptable risk (life safety).

3.3 Site Investigation Requirements

Site exploration shall be carried out by digging test pits, two as a minimum, and more if the subsurface soil condition shows a significant variation in soil type.

Generally, the minimum depth of exploration for a building covered by this RUD shall be 2 m. In hilly areas, exploration up to the depth of sound bed-rock, if it lies shallower than 2 m, should suffice.

No exploration shall be required if the site is located on rock or on fluvial terraces (Tar) with boulder beds.

The soils encountered in the test pits should be classified as per **Table 3.1.**

3.4 Allowable Bearing Pressure

The allowable bearing pressure that can be used is given in **Table 3.1** in conjunction with the visual classification of the subsurface soil type.

TABLE 3.1 : FOUNDATION SOIL CLASSIFICATION AND SAFE BEARING CAPACITY

	Type of Foundation Materials	Foundation Classification	Presumed Safe Bearing Capacity, kN/m^2
1.	Rocks in different state of weathering, boulder bed, gravel, sandy gravel and sand-gravel mixture, dense or loose coarse to medium sand offering high resistance to penetration when excavated by tools, stiff to medium clay which is readily indented with a thumb nail.	Hard	≥ 200
2.	Fine sand and silt (dry lumps easily pulverised by the finger), moist clay and sand-clay mixture which can be indented with strong thumb pressure	Medium	≥ 150 and < 200
3.	Fine sand, loose and dry; soft clay indented with moderate thumb pressure	Soft	≥ 100 and < 150
4.	Very soft clay which can be penetrated several centimetres with the thumb, wet clays	Weak	≥ 50 and < 100

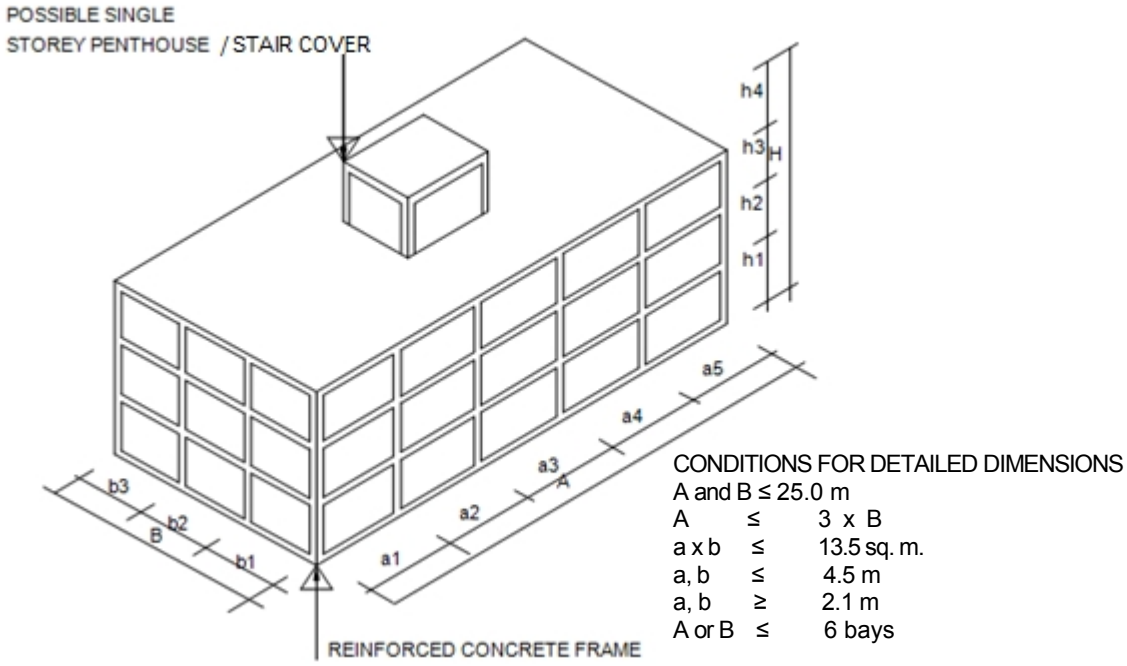
4 The Building Structure

4.1 Description

The structure is a reinforced concrete frame without any contribution of masonry infill walls in resisting the vertical or seismic loads. The frame shall comply with **Clause 4.1, 4.2** and be designed to resist earthquake forces as a bare frame.

4.2 Restrictions on the Structural Layout

For a structure to be built using this RUD Guideline, it shall comply with the restrictions set out below. If the structure does not comply, it must be designed in accordance with the Standards referred to in **Clause 1.2** or latest appropriate standard.



[Note: 1. A is longer side of Building and B is shorter side of building
2. Openings can be provided as per functional/architectural requirements.
3. Foundation is not shown.]

Figure 4.1: Restrictions in Reinforced Concrete Frame

The restrictions are:

(a) Neither *A* nor *B* shall exceed 6 bays in length nor 25 metres. Each bay shall not exceed 4.5 m, maximum panel area a x b <13.5 sq.m. as shown in **Figure 4.1**.

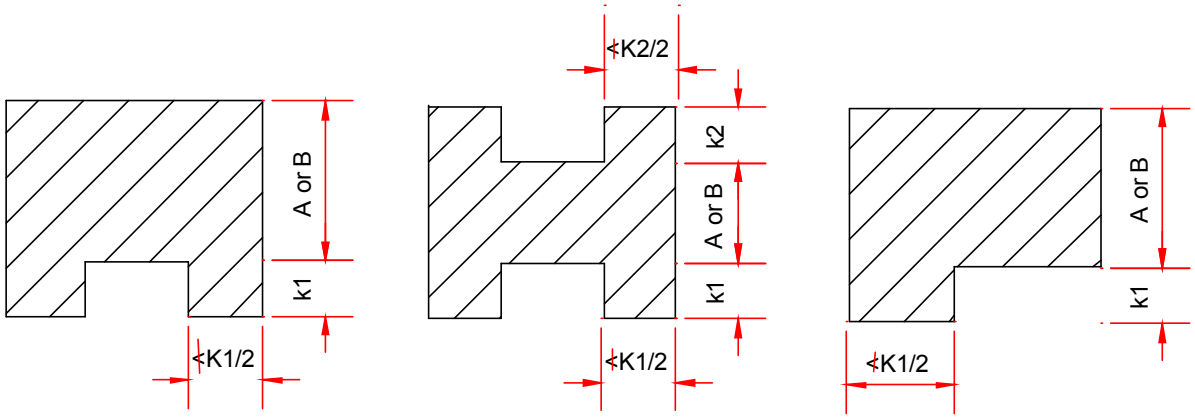
(b) *A* shall be not greater than 3 *B* .

(c) *H/B* shall not exceed 3.

(d) The maximum height of the structure is 11 m or 3 storeys, whichever is less, from the level of lateral restraint. Within an 11 m height, there may be an additional storey of smaller plan area. The area of this shall not exceed 25 % of the area of a typical floor, as given in **Figure 4.1**. If this limit is exceeded, it shall be considered as an additional storey and not permitted.

(e) The length of wings on the structure shall be restricted such that K_1 and K_2 shall be less than the lesser of 0.15 *A* or 0.15 *B*. The width of the wings shall be restricted as shown in **Figure 4.2**. The plan shape of the building excluding wings shall be rectangular.

(f) All columns resisting lateral load shall be vertical and shall continue on the same centreline down to foundation level. The top storey may, however, be smaller or have a different geometry subject to the provisions of subparagraph (e) above



K_1, K_2 < 0.15 A or 0.15B, whichever is less.

Figure 4.2: Restrictions on Plan Projection

(g) No walls except a parapet wall shall be built on a cantilevered slab. Such walls shall be constructed only if the cantilevered slab is framed with beams. Protection of Parapet wall against overturning shall be assumed by providing vertical reinforcement and horizontal band as per clause 9.

(h) The foundation shall be at a uniform level.

(i) Buildings shall not have a soft storey.

(j) The size of cantilever projection should not exceed 1 metre.

5 Construction Materials

5.1 Concrete

The concrete to be used in footings, columns, beams and slabs, etc., shall have a minimum crushing strength of 20 N/mm² (Nominal mix, 1:1.5:3) at 28 days for a 150 mm cube.

Cement: Cement shall be as fresh as possible. Any cement stored for more than two months from the date of receipt from the factory should either be avoided or tested and used only if the test results are found to be satisfactory. Any cement which has deteriorated or hardened shall not be used. All cement used shall be Ordinary Portland Cement meeting the requirements of NS: 049-2041 or Pozzolona Portland Cement (PPC) meeing the requirement of NS: 385-2054. It is advisable to use cement which has obtained the NS mark if independent tests are not carried out.

Coarse Aggregates: Coarse aggregates shall consist of crushed or broken stone and shall be hard, strong, dense, durable, clean, of proper grading and free from any coating likely to prevent the adhesion of mortar. The aggregate shall be generally angular in shape. As far as possible, flaky, elongated pieces shall be avoided. The aggregate shall conform to the requirements of NS: 305-2050 and NS: 297-2050.

The coarse aggregates shall be of following sizes:

(a) Normal cement concrete with a thickness of 100 mm and above - graded from 20 mm downwards

(b) Cement concrete from 40 mm to 100 mm thick - graded from 12 mm downwards

Sand: Sand shall consist of a siliceous material having hard strong, durable, uncoated particles. It shall be free from undesirable amounts of dust lumps, soft or flaky particles, shale, salts, organic matter, loam, mica or other deleterious substances. In no case shall the total of all the undesirable substances exceed five percent by weight. The sand shall confirm to the requirements of NS: 51-204.

5.2 Brickwork

The brick masonry shall be built with the usually specified care regarding pre-soaking of bricks in water, level bedding of planes fully covered with mortar, vertical joints broken from course to course and their filling with mortar fully.

Bricks: The bricks shall be of a standard rectangular shape, burnt red, hand-formed or machine-made, and of crushing strength not less than 3.5 N/mm². The higher the density and the strength, the better they will be. The standard brick size of 230 x 115 x 57 mm with 10 mm thick horizontal and vertical mortar joints is preferable. Tolerances of -10 mm on length, -5 mm on width and ±3 mm on thickness shall be acceptable for the purpose of thick walls in this RUD. The brick shall confirm to the requirements of NS: 01-2035.

Wall Thickness: A minimum thickness of one half-brick and a maximum thickness of one brick shall be used.

Mortar: Cement-sand mixes of 1:6 and 1:4 shall be adopted for one-brick and half-brick thick walls, respectively. The addition to the mortars of small quantities of freshly hydrated lime in a ratio of ¼ to ½ of the cement will greatly increase their plasticity without reducing their strength. Hence, the addition of lime within these limits is encouraged.

Plaster: All plasters should have a cement-sand mix not leaner than 1:6. They shall have a minimum 28 days cube crushing strength of 3 N/mm².

5.3 Reinforcing Steel Bars

Reinforcing steel shall be clean and free of loose mill-scale, dust, loose rust and coats of paints, oil, grease or other coatings, which may impair or reduce bond. It shall conform to the following NS standards.

High-strength deformed bars conforming to NS: 191-2046 with f_y = 415 N/mm² shall be used for reinforcing all masonry and concrete.

However, high strength deformed steel bars, produced by the thermo-mechanical treatment process, of grades Fe 500 , having elongation more than 14.5 percent and conforming to other requirements of IS 1786:2008 / NS: 191-2046 may also be used for the reinforcement. (Ref. IS 13920; Cl 5.3)

[Note: 1. in the presentation of this RUD Guidelines, f_y = 415 N/mm², 500 N/mm² steel is assumed for main bars in beams and columns. For using any other steel with lower values of f_y, the steel area shall be correspondingly increased.

6 Design Procedure Adopted

6.1 Procedure Outline

The simplified design procedure comprises the following stages:

a) Conforming that the building plan meets the structural layout restrictions (**Clause 4.1, 4.2**).

b) Calculation of total horizontal seismic base shear on the building using 500 years return period response spectrum

c) Preparations of 3D numerical model of the building

d) Distribution of total horizontal seismic base shear up the height of the building (**Clause 6.3**).

e) Developing Envelop force diagram of beam and design of beam as per NBC: 110-1994
f) Design of Column for outputs of critical load combinations
g) Check for strong column weak beam actions
h) Check for joint shear force

i) Detailing of the structural elements :

   i. The frame, beam and column (**Clauses 7.1 – 7.3**)
   ii. Recommendation for minimum Sizes and reinforcement (**Clause 7.3.2**)

j) Reinforcing of non-load-bearing walls (**Section 8**)

k) Reinforcing of parapets (**Section 9**)
l) Reinforcing of foundations

6.2 Total Horizontal Seismic Base Shear

The sample building structure was designed to withstand a total horizontal seismic base shear, V, calculated in accordance with the formula:

$$V = C_d \, x \, W_t \qquad \textbf{(6.1)}$$

Where,

W_t is the combination of the total vertical dead load and 25 % of the live loads above the level of lateral restraint provided by the ground.

6.2.1 Design Seismic Coefficient[1]

The design seismic coefficients, C_d, for the design of frames without masonry in-fills in the various zones are:

Zone A = 0.09 Zone B = 0.08, Zone C = 0.072

Where a building location lies close to a zone boundary so that its particular zone is uncertain, then the building was assumed to fall in the zone requiring the higher value of basic seismic coefficient.

The detailing presented in this building code is based upon the C_d = 0.09 and generalised for all other zone also.

6.3 Distributing Total Horizontal Seismic Base Shear

The total horizontal base shear, V, shall be distributed up the height of the building in accordance with the formula (refer to **Figure 6.1)**:

$$F_t = V\left(\frac{W_t\ h_i}{\sum_i W_t h_i}\right) \qquad \textbf{(6-2)}$$

Where,

F_i is the load applied at the level designated as i.

W_i is the proportion of W_t at i^{th} level.

h_i is the height of level i above of level of lateral restraint imposed by the ground.

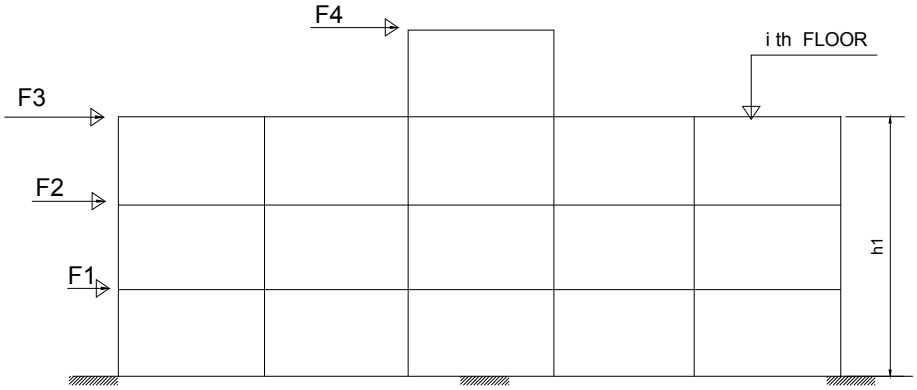


Figure 6.1: Floor Level Lateral Forces

[1] *Seismic coefficients are in accordance with NBC 105with modified Response spectra from 300 year Return period to 500 year return period, for ductile frames of ordinary building on a soft grade of soil.*

6.4 Preparation of Numerical Model of Building

3Dimennsional Numerical bare frame model was prepared; The Seismic load evaluated in 6.3 applied at C.G. of each storey with additional eccentricity defined in NBC105.

7 Design of the Frames

7.1 Frames

All frames are designed:

(a) To support the applied vertical gravity loads (including the weight of the walls) without assistance from the walls, and

(b) For seismic condition using forces as per **Clause 6.1**.

(c) Design Load combinations for dead load, live load and earthquake load should be considered as per NBC 105:1994 and NBC110:1994

7.2 Frame Design

The members and joints were then designed in accordance with NBC 110:1994 / IS 456:2000 and IS13920 and detailed to achieve ductile deformations under severe earthquakes.

The recommendations for member sizes and minimum reinforcement in all components are shown in **Figures 7.1** to **7.4**. The reinforcement shall also comply with the applicable sections.

7.2.1 Basis of Recommendations

The recommended sizes of members and the reinforcement are based on analysis and calculations of representative models using the following data:

Building Occupancy	:	Ordinary Building
Column Plan Bay Dimension	:	3m x 3m to 4.5m x 3.0m
Bay Nos.	:	2 x 2 to 6 x 6
Number of Storeys	:	up to three plus stair cover

Storey Height

For terai region preferred storey height = 3.35 m
For other region preferred storey height = 2.75 m

Based up on the climate condition any of the option can be used

Wall Thicknesses	:	up to 115 mm thick brick wall or equivalent for all internal

		walls and up to 230 mm thick brick wall or equivalent for all external walls
Cantilever Floor Projection	:	1.0 m (from centre-line of beam)
Concrete mix	:	M20 (20 N/mm² cube crushing strength at 28 days) minimum
Reinforcement	:	Fe415 (minimum yield strength = 415 N/mm²), Fe500 (minimum yield strength = 500 N/mm²)
Mortar	:	Minimum 1:4 cement-sand mortar for half-brick thick wall and 1:6 cement-sand mortar for one-brick thick
Bricks	:	Minimum crushing strength 3.5 N/mm²

7.2.2 Recommended Members Sizes and Minimum Reinforcement

Slab

Roof and Floors

Thickness : 125 mm

Steel : 8ϕ (Fe 415) or 8ϕ (Fe 500) bars as shown in **Figure 7.1**.

Beams

Roof and floors (both directions)

Width : 230 or 250[1] mm

Depth : 355 mm overall depth including slab

Plinth Tie beam (both directions)

Width : 230 mm

Depth : 230 mm overall depth

Longitudinal Steel:

The top and bottom steel reinforcement bars are given in **Table 7.1** for different spans. The placing of steel shall meet the requirements specified in **Figure 7.2**.

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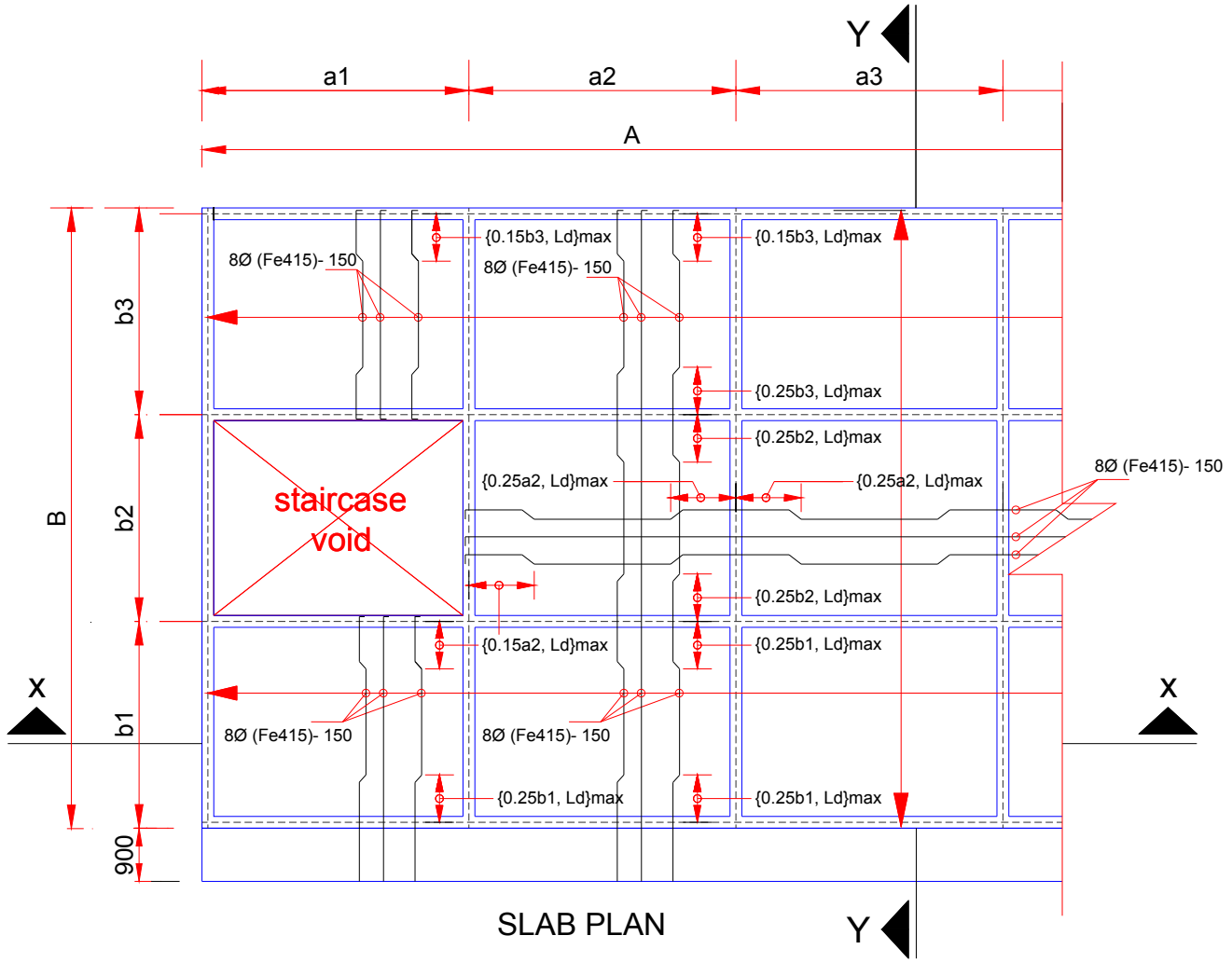
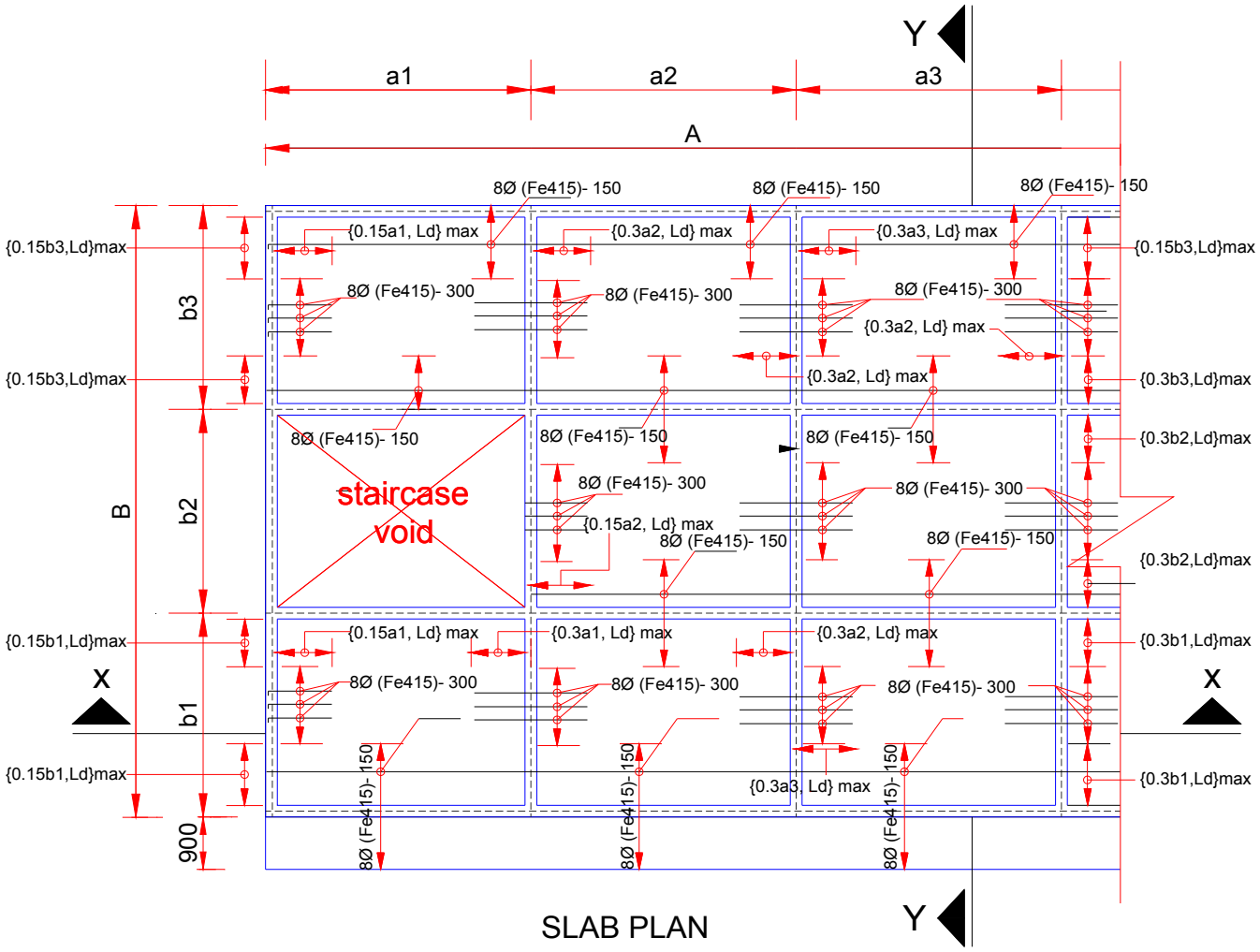
[1] *Width of beam should be adopted depending on the thickness of wall i.e. as per the availability of brick sizes.*

Figure 7.1 : Slab Reinforcement Details



Slab Bottom Continuous/Cranked bars Details along X- and Y-directions

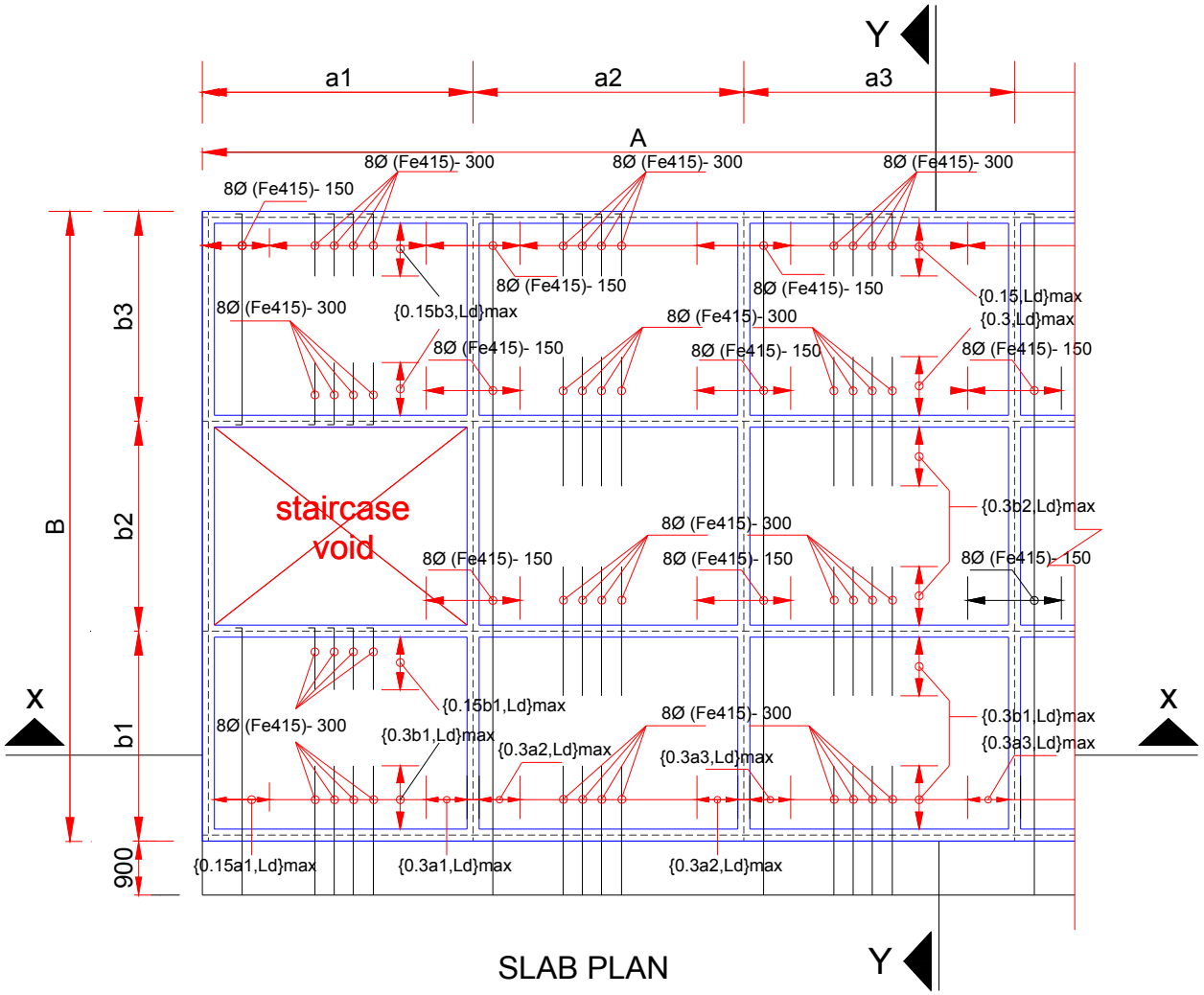
Figure 7.1 : Slab Reinforcement Details Continued…….



SLAB PLAN

Top Extra reinforcement Detail in x-x direction

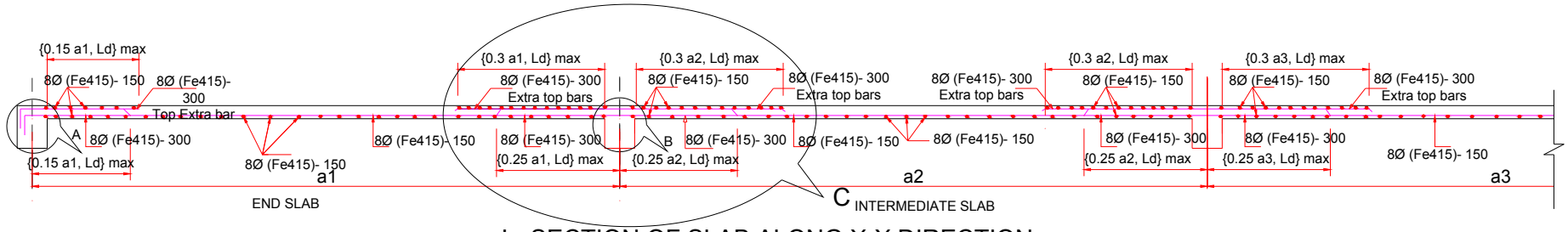
Figure 7.1 : Slab Reinforcement Details Continued…….



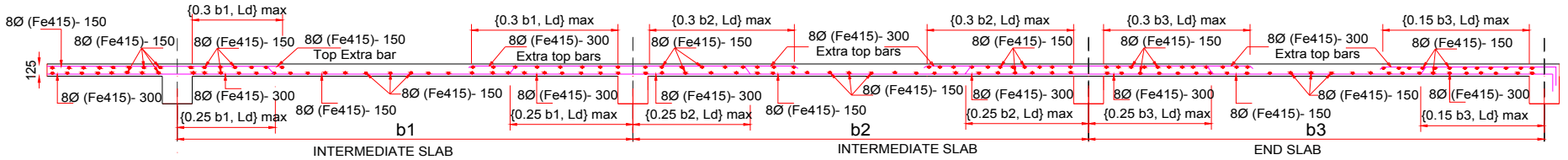
SLAB PLAN

Top Extra reinforcement Detail in Y-Y direction

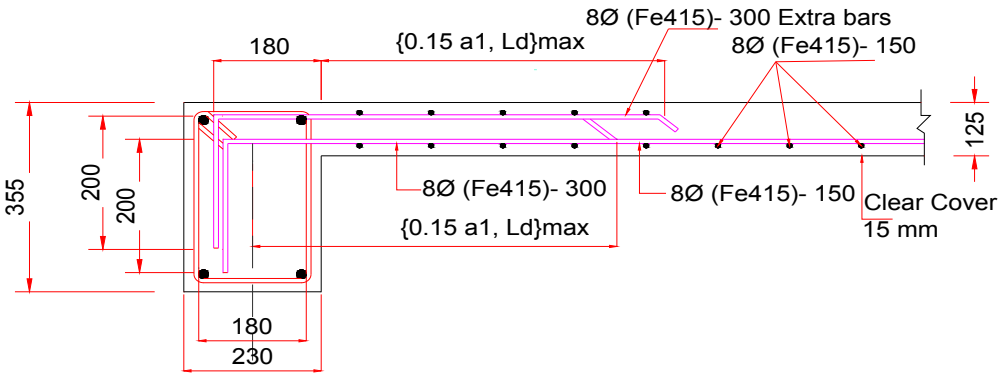
Figure 7.1 : Slab Reinforcement Details Continued…….



L- SECTION OF SLAB ALONG X-X DIRECTION

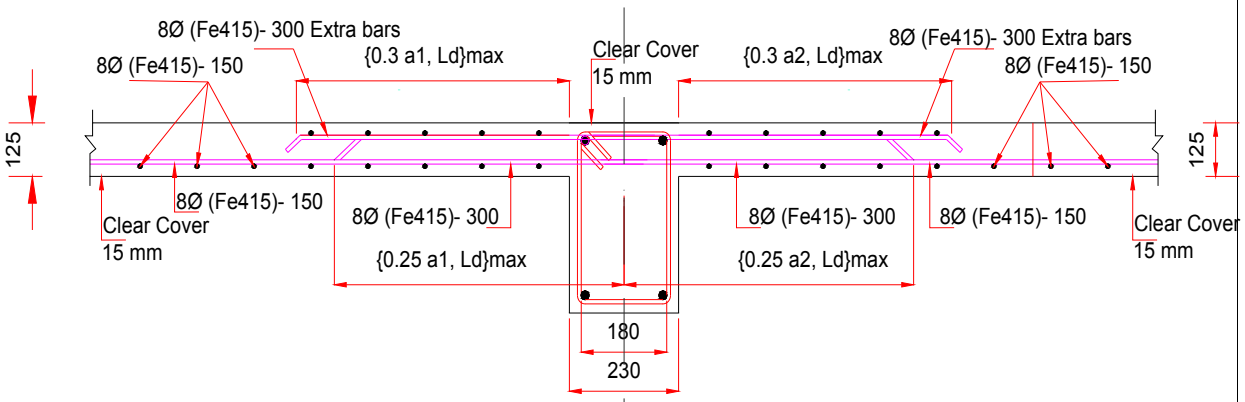


L- SECTION OF SLAB ALONG Y-Y DIRECTION



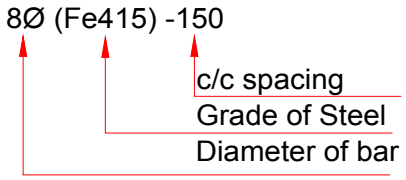
EDGE SLAB DETAIL - A

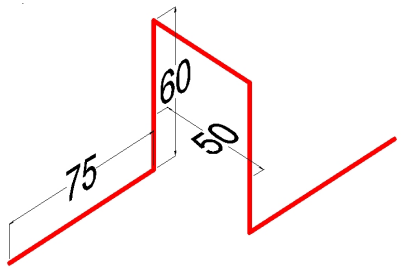
Figure 7.1 : Slab Reinforcement Details Continued…….



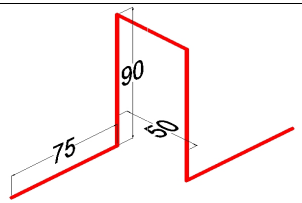
DETAIL AT - B

Notes: For slab, steel grade Fe 500 can also be used without changing bar diameter





8 mm dia Chair resting on Bottom bars
Option-I



8 mm dia Chair resting on Slab formwork
Option-II

Chair bar for slab

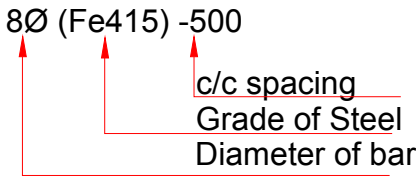
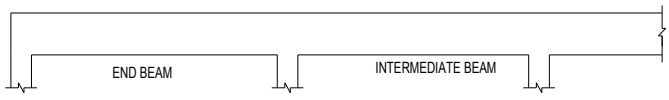
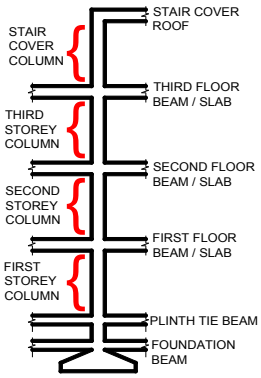


TABLE 7.1: LONGITUDINAL STEEL IN BEAMS



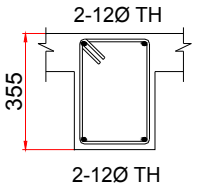
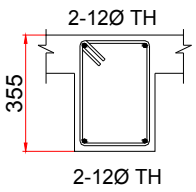
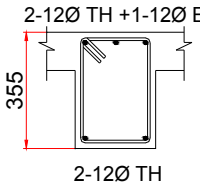
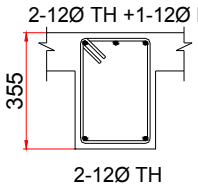
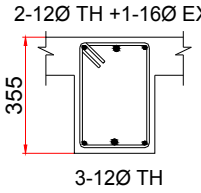
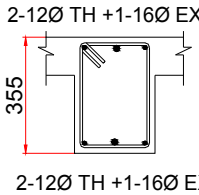
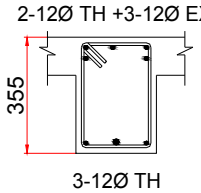
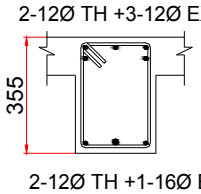
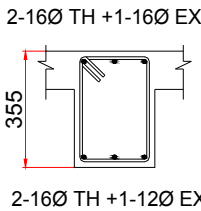
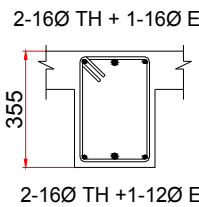
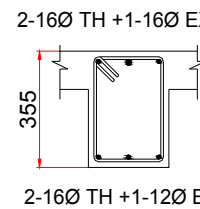
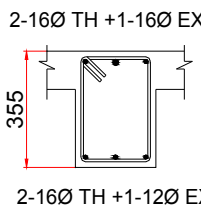
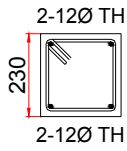
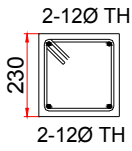
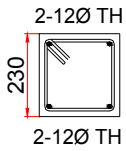
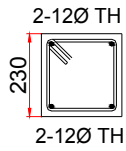
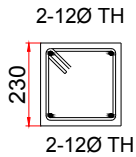
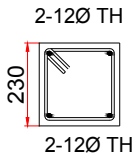
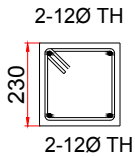
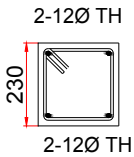


Fe 415, fy=20 MPa, Beam design output summary for all Building covered by this code

	Span < 3 m		3m ≤ Span < 3.5 m	
	Intermediate Beam	End Beam	Intermediate Beam	End Beam
Roof and stair cover Beam	2-12Ø TH / 355 / 2-12Ø TH	2-12Ø TH / 355 / 2-12Ø TH	2-12Ø TH / 355 / 2-12Ø TH	2-12Ø TH / 355 / 2-12Ø TH
Second Floor Beam	2-12Ø TH +1-12Ø EXT / 355 / 3-12Ø TH	2-12Ø TH +1-12Ø EXT / 355 / 3-12Ø TH	2-12Ø TH +1-16Ø EXT / 355 / 3-12Ø TH	2-12Ø TH +1-16Ø EXT / 355 / 3-12Ø TH
First Floor Beam	2-16Ø TH +1-16Ø EXT / 355 / 3-12Ø TH	2-16Ø TH +1-16Ø EXT / 355 / 3-12Ø TH	2-16Ø TH +1-12Ø EXT / 355 / 2-16Ø TH +1-12Ø EXT	2-16Ø TH + 1-12Ø EXT / 355 / 2-16Ø TH +1-12Ø EXT
Plinth Tie Beam	2-12Ø TH / 230 / 2-12Ø TH	2-12Ø TH / 230 / 2-12Ø TH	2-12Ø TH / 230 / 2-12Ø TH	2-12Ø TH / 230 / 2-12Ø TH
Foundation Tie Beam	2-12Ø TH / 230 / 2-12Ø TH	2-12Ø TH / 230 / 2-12Ø TH	2-12Ø TH / 230 / 2-12Ø TH	2-12Ø TH / 230 / 2-12Ø TH

TABLE 7.1: LONGITUDINAL STEEL IN BEAMS CONTINUED…….

Fe 415, fy=20 MPa, Beam design output summary for all Building covered by this code

	3.5 m≤Span <4 m		4.0 m≤Span ≤4.5 m	
	Intermediate Beam	End Beam	Intermediate Beam	End Beam
Roof and stair cover Beam				
Second Floor Beam				
First Floor Beam				
Plinth Tie Beam				
Foundation Tie Beam				

[Note:

1. *2-16 TH stands for 2 number of 16 mm diameter of steel grade Fe415 bar throughout the beam. 2-16 EXT stands for 2 number of Extra (Additional) 16 mm diameter of steel grade Fe415 bar at beam end near junction.*
2. *Extra top bars coming from adjacent span shall not be curtailed if the span under consideration is equal to minimum span of 2.1 m.*
3. *In case of two adjacent beams of different span, top bars for longer span shall govern.*
4. *For Beam detailing with Fe 500 grade steel simply convert area with equation: 415*{area corresponding to Fe 415 Steel} = 500*{area corresponding to Fe 500 Steel}]*
5. *Beam Width, B=230 mm [for corresponding brick wall thickness ≤ 230mm]*
   =250 mm [for corresponding brick wall thickness = 250mm]

Transverse Stirrups:

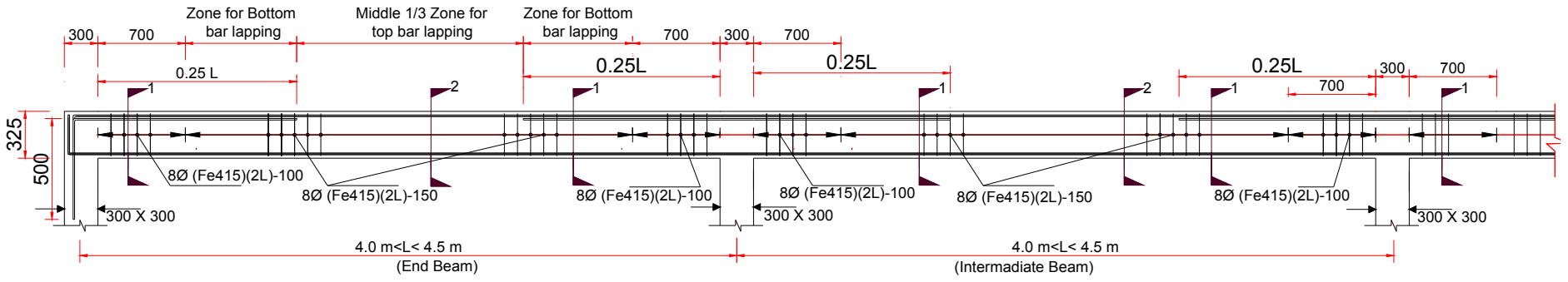
The transverse stirrups are calculated and presented in **Table 7.2** for different spans. The placing of transverse stirrups shall meet the requirements set out in **Figure 7.2.** The depth of the foundation shall not be less than 1.2 m.

TABLE 7.2: TRANSVERSE STIRRUPS IN BEAMS (All stirrups are 2-legged)

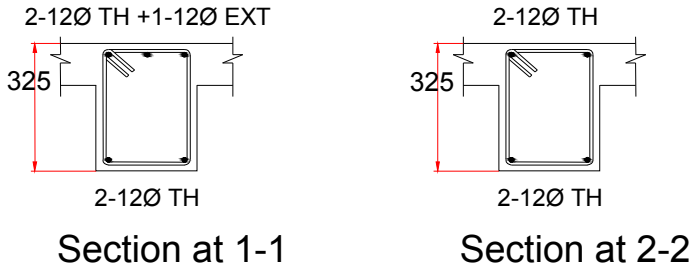
Level	End Zone, Special Confining Reinforcement (up to 2d from face of column)		Remaining Mid Zone, (remaining mid part)	
	Fe 415	Fe 500	Fe 415	Fe 500
Roof and stair cover Beam	8 mm Ø @ 100 mm c/c	7 mm Ø @ 100 mm c/c	8 mm Ø @ 150 mm c/c	7 mm Ø @ 150 mm c/c
Second Floor Beam	8 mm Ø @ 100 mm c/c	7 mm Ø @ 100 mm c/c	8 mm Ø @ 150 mm c/c	7 mm Ø @ 150 mm c/c
First Floor Beam	8 mm Ø @ 100 mm c/c	7 mm Ø @ 100 mm c/c	8 mm Ø @ 150 mm c/c	7 mm Ø @ 150 mm c/c
Plinth Tie Beam	8 mm Ø @ 150 mm c/c	7 mm Ø @ 150 mm c/c	8 mm Ø @ 150 mm c/c	7 mm Ø @ 150 mm c/c
Foundation Tie Beam	8 mm Ø @ 150 mm c/c	7 mm Ø @ 150 mm c/c	8 mm Ø @ 150 mm c/c	7 mm Ø @ 150 mm c/c

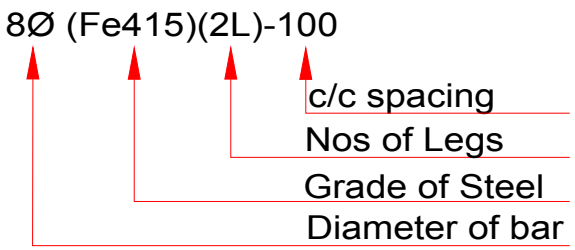
Note:
{Ref IS13920; Cl 5.3}
Steel reinforcements of grade Fe 415 (see IS 1786: 1985) or less, shall be used.
However, high strength deformed steel bars, produced by the thermo-mechanical treatment process, of grade Fe 500, having elongation more than 14.5 percent and conforming to other requirements of IS 1786 : 1985 may also be used for the reinforcement.

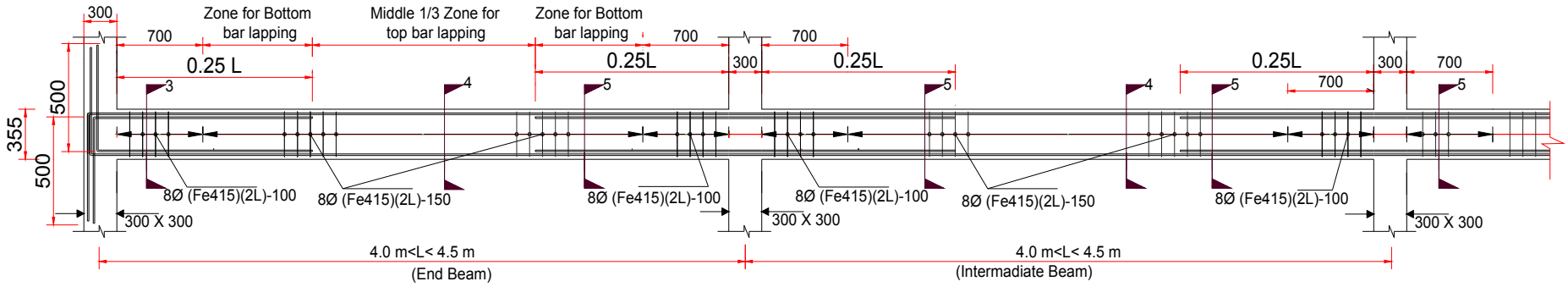
Figure 7.2: Beam Details



Roof Typical Beam Details { Third Floor}

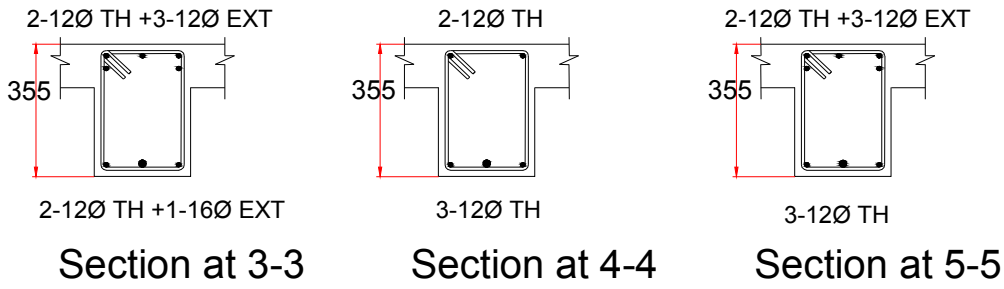


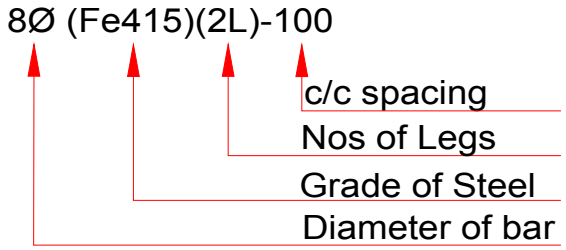


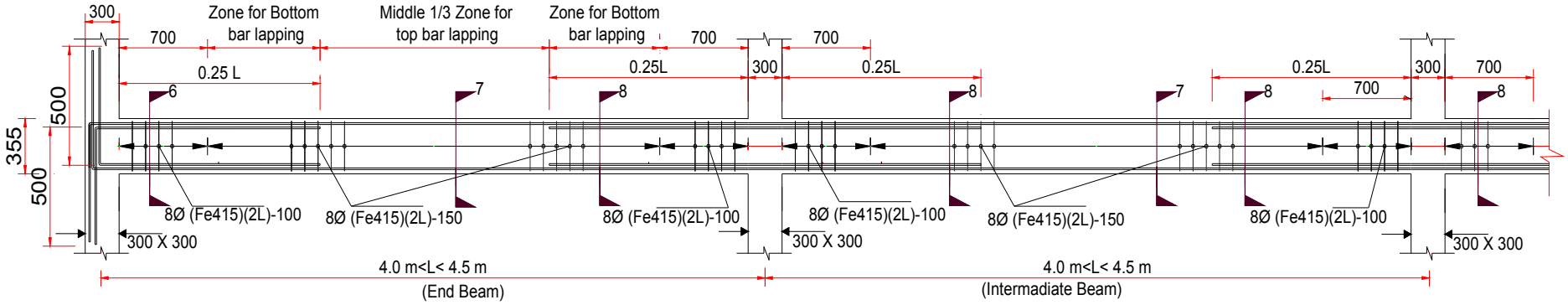


Second Floor Typical Beam Details

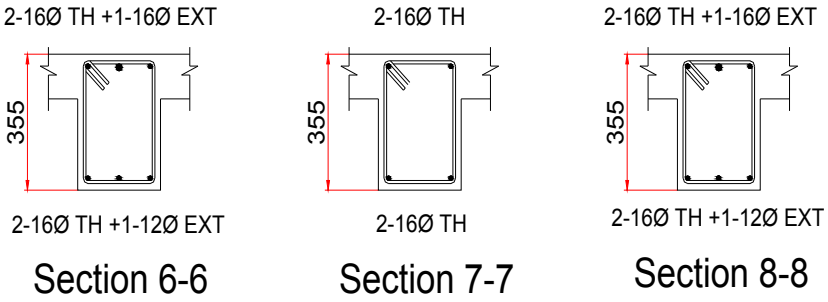
Figure 7.2: Beam Details Continued……..







First Floor Typical Beam Details



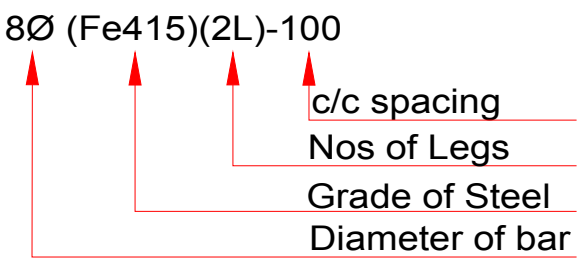
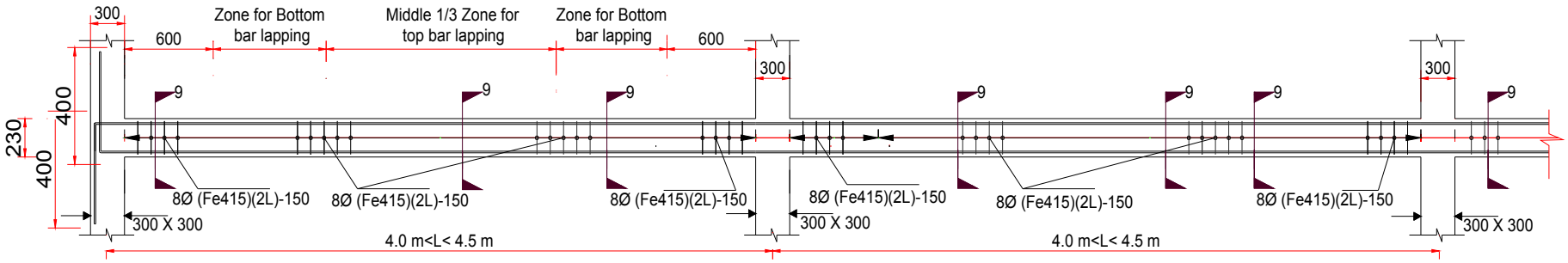


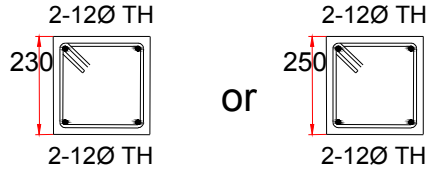
Figure 7.2: Beam Details Continued……..



Foundation Level and Plinth Level Tie Beam Details

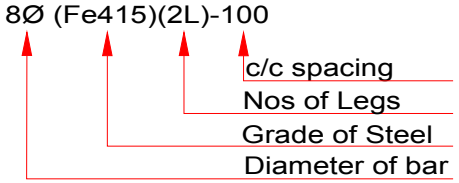
Note:

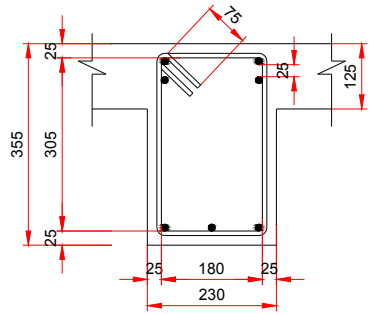
The foundation level tie beam is required only in the case when the foundation lies in soft soil.



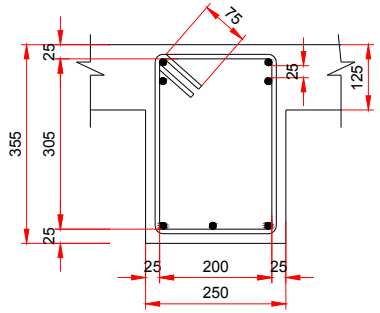
Selection of tie beam depth can be done based up on available size of formwork

Section at 9-9





Beam Typical Details, 230X355



Beam Typical Details, 250X350; for Tarai Region

General Notes:

Lapping of top and bottom bar is allowed only in the zone shown in Fig 7.3(typical beam detail) .
Not more than 50% of the bars should be spliced at a section.
If longer and smaller apans exists adjacent, top and bottom additional bars of the longer span shall govern.
All Concrete grades are of M20 {1:1.5:3(Cement:Sand:Aggregate)}.
Curtail extra top and bottom bars 0.3L away from support.
The bars extending through adjacent spans to any span equal to 2.1 m shall not be curtailed and stirups be provided same as the ends of the adjacent beam.
The exposed surfaces of concrete shall be kept continuously water damp for at least one week.
In normal circumstances formwork of slab and beam can be removed after 3 weeks of concreting.
In normal circumstances formwork of column can be removed after 48 hours of concreting.
Lapping of bars should not be less than development length (L_d) and L_d is given as in table below.

TABLE 7.3: Development length of bars for M20 grade of concrete

Diameters of bars, Ø, mm	For Fe 415, $L_d = 47Ø$, mm	For Fe 500, $L_d = 57Ø$, mm
6	280	340
8	375	455
10	470	570
12	565	685
16	750	910

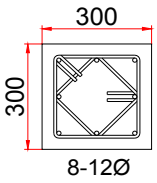
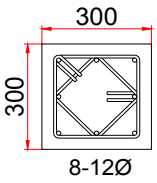
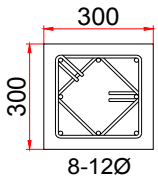
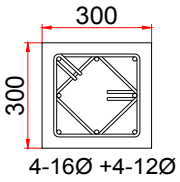
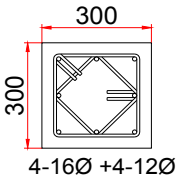
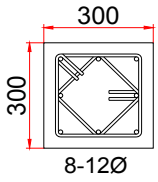
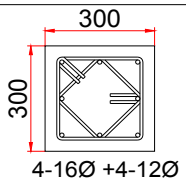
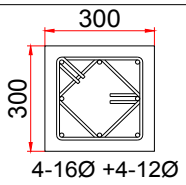
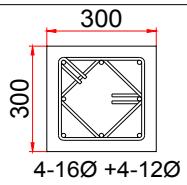
Columns

Size and Longitudinal Steel:

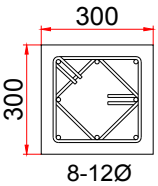
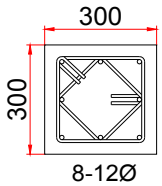
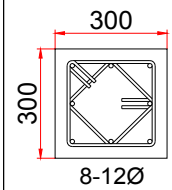
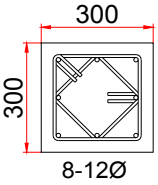
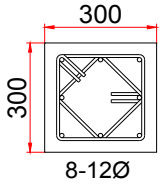
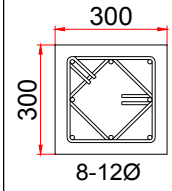
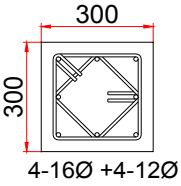
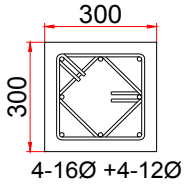
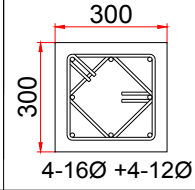
Gross sections of column and longitudinal steel are calculated and presented in **Table 7.4**.

TABLE 7.4: COLUMN SIZES AND LONGITUDINAL STEEL

Fe 415, fy=20 MPa,
Column design output for All buildings covered by this code

	Corner Column	Face Column	Internal Column
Third Storey			
Second Storey			
First Storey			

Fe 500, fy=20 MPa,
Column design output for All buildings covered by this code

	Corner Column	Face Column	Internal Column
Third Storey			
Second Storey			
First Storey			

*The Stair Cover columns detailing are same as that of Third Storey.

[Note:

1. *Fe500 TMT bars can only be used if elongation of steel bar is above 14.5%*
2. *8-12ø stands for 8 numbers of 12 mm ϕ steel bars*
3. *Clear cover for longitudinal bars should be 40 mm]*

Transverse Stirrups:

The transverse stirrup ties in all columns shall be:

For Fe415 Steel

Ends of columns for 600 mm length {Special Confining Reinforcement}	- 08mm ø @ 100 mm c/c
Remaining height	- 08mm ø @ 150mm c/c

For Fe500 Steel

Ends of columns for 600 mm length Special Confining Reinforcement}	- 07mm ø @ 100mm c/c
Remaining height	- 07mm ø @ 150mm c/c

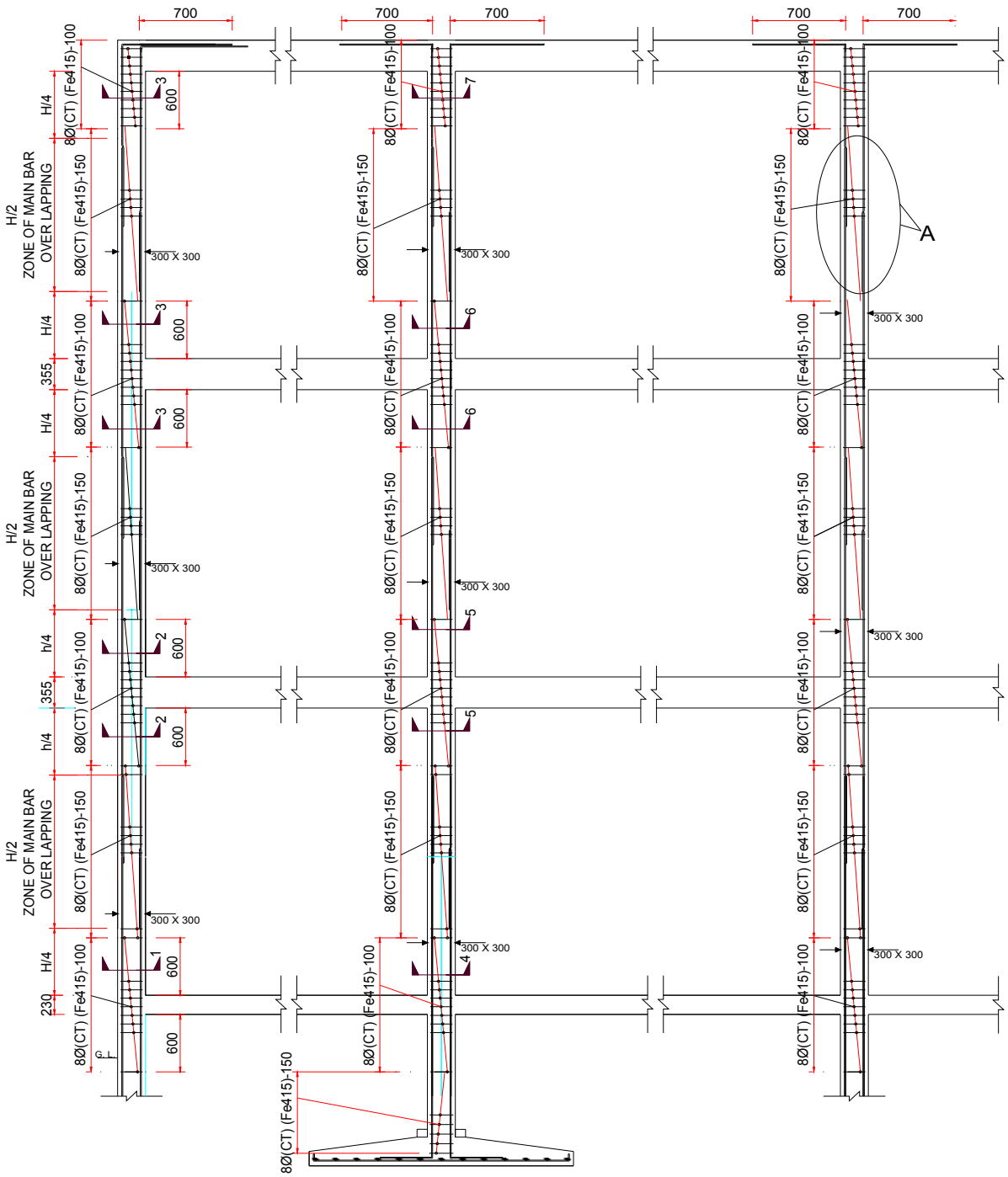
[Note: 1. Continue the column stirrups as specified as special confining reinforcements, if column stands adjacent to a window or such opening to take care of the short-column effect.

2. All stirrups are of a closed type.

3. 135^o Hook should be used with 75mm hook length]

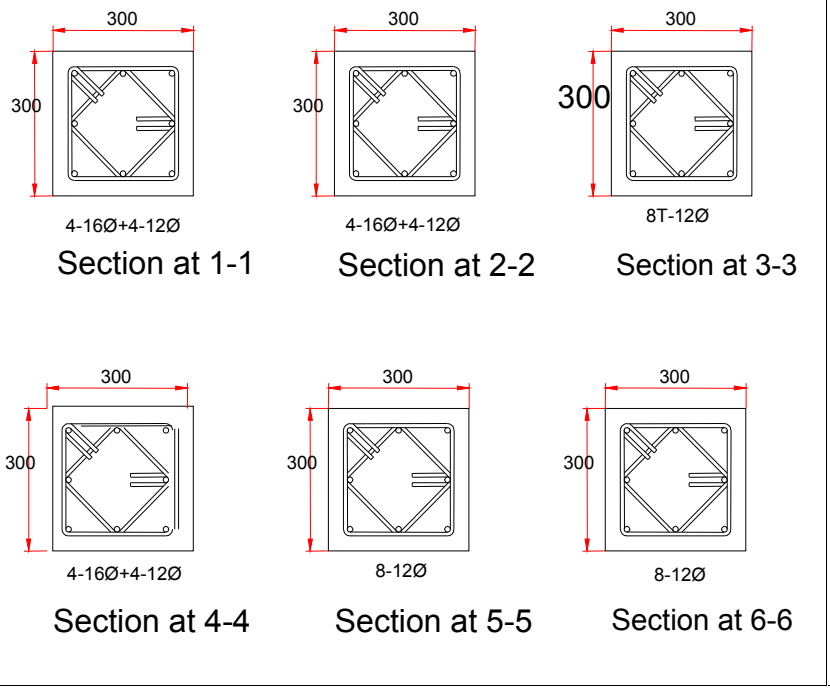
Details of columns shall be as specified in **Figure 7.3**.

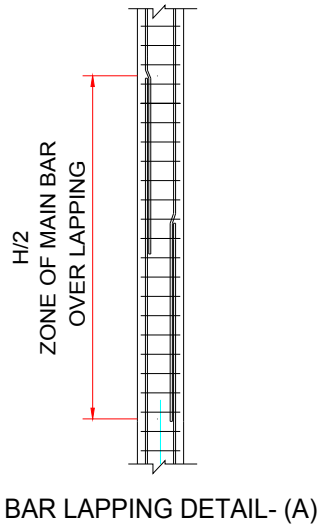
Figure 7.3: Column Details

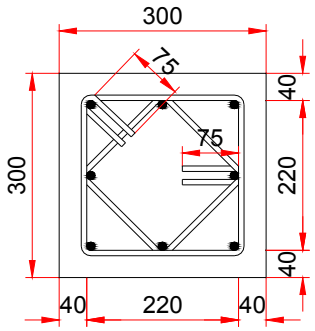


SECTION THROUGH INTERIOR FRAME

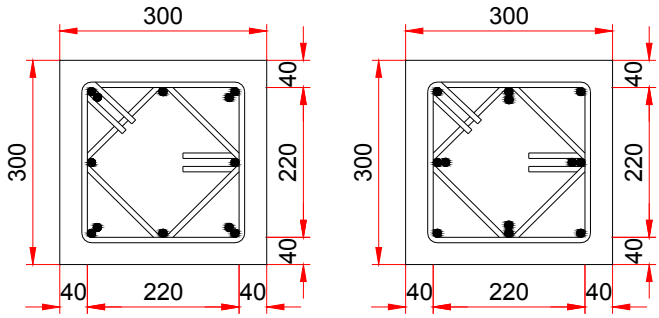
Figure 7.3: Column Details Continued…..



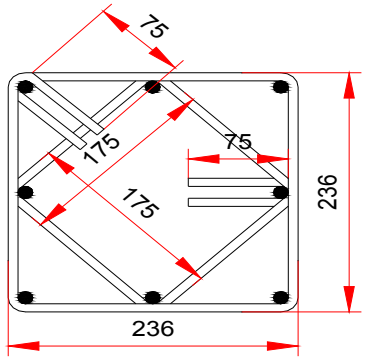




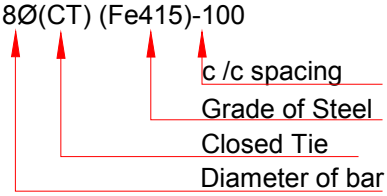
Typical Column Section

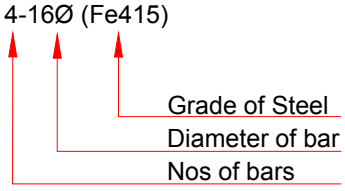


Typical Column Section Near Lapping Zone



Size of STRPS of dia 8 mm

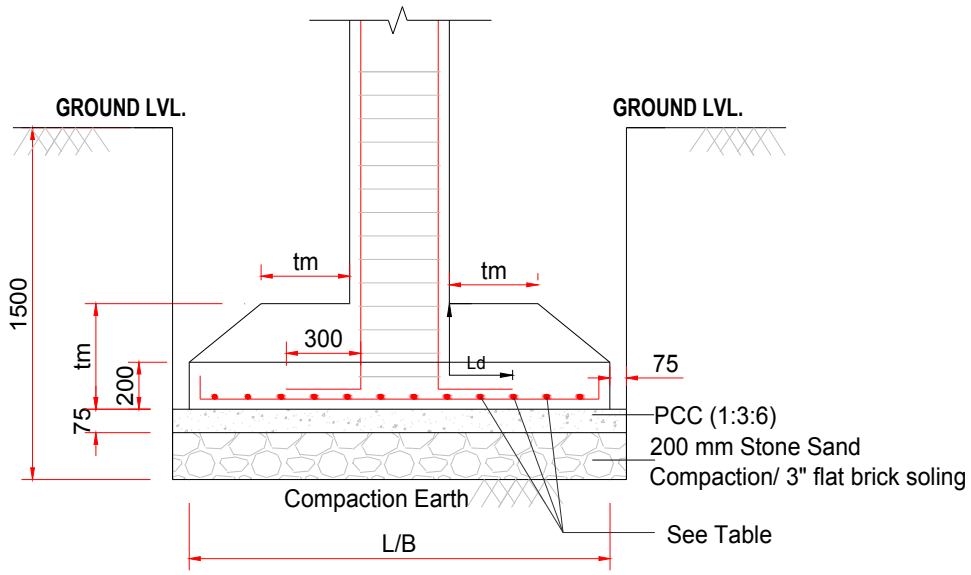




Pad Foundations

Sizes and reinforcement in pad foundations for different soil types and loadings are presented in **Tables 7.5A to 7.5D**. All foundations are individual tapering-type pads. Details of foundations shall be as given in **Figure 7.4.**

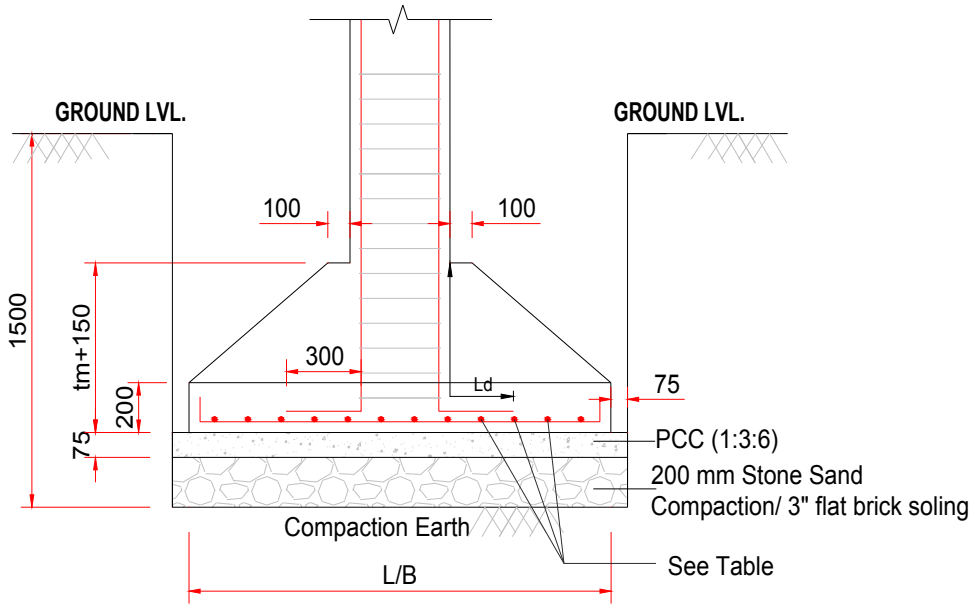
Figure 7.4: Pad Foundations



FOOTING SECTION OPTION 1

Foundation Dimensions Option 1

All dimensions are in mm



FOOTING SECTION OPTION 2

Foundation Dimensions Option 2

All dimensions are in mm

Side cover for foundation = 50 mm

Cover from bottom face = 50 mm

TABLE 7.5A: PAD FOUNDATION SIZE FOR WEAK SOILS
(Safe bearing capacity = 50 kN/m²)

Column Type	Foundation Plan L x B (m)	Maximum thickness t_m (mm)	Reinforcement each way A_s
Corner	2.2 x 2.2	300	11 - 12ϕ
Face	2.4 x 2.4	300	10 - 12ϕ
Interior	3.0 x 3.0	400	14 - 12ϕ

[Note: 1.
11- 12ϕ *Stands for eleven no of 12 mm diameter Fe415 or Fe 500 bars. Use same dia. bar and same spacing for Fe415 and Fe500 grade steel.]*

TABLE 7.5B: PAD FOUNDATION SIZE FOR SOFT SOILS
(Safe bearing capacity = 100 kN/m²)

Column Type	Foundation Plan L x B (m)	Maximum Thickness t_m (mm)	Reinf. Each Way A_s
Corner	1.5 x 1.5	300	7- 12ϕ
Face	1.65 x 1.65	300	8- 12ϕ
Interior	2.1 x 2.1	400	10- 12ϕ

TABLE 7.5C: PAD FOUNDATION SIZE FOR MEDIUM SOILS
(Safe Bearing Capacity = 150 kN/m²)

Column Type	Foundation Plan L x B (m)	Maximum Thickness t_m (mm)	Reinforcement Each Way A_s
Corner	1.25 x 1.25	300	6- 12ϕ
Face	1.4 x 1.4	300	7- 12ϕ
Interior	1.7 x 1.7	400	8- 12ϕ

TABLE 7.5D: PAD FOUNDATION SIZE FOR HARD SOILS
(Safe bearing capacity = 200 kN/m²)

Column Type	Foundation Plan L x B (m)	Maximum Thickness t_m (mm)	Reinf. each way A_s
Corner	1.1 x 1.1	300	5- 12ϕ
Face	1.2 x 1.2	300	6- 12ϕ
Interior	1.5 x 1.5	400	7- 12ϕ

Toe Wall: All plinth beams shall be constructed on a toe wall [as, fig. 7.5(a), 7.5(b)], or on plinth wall supported by foundation tie beam [as fig. 7.5(c), 7.5(d), 7.5(e)].

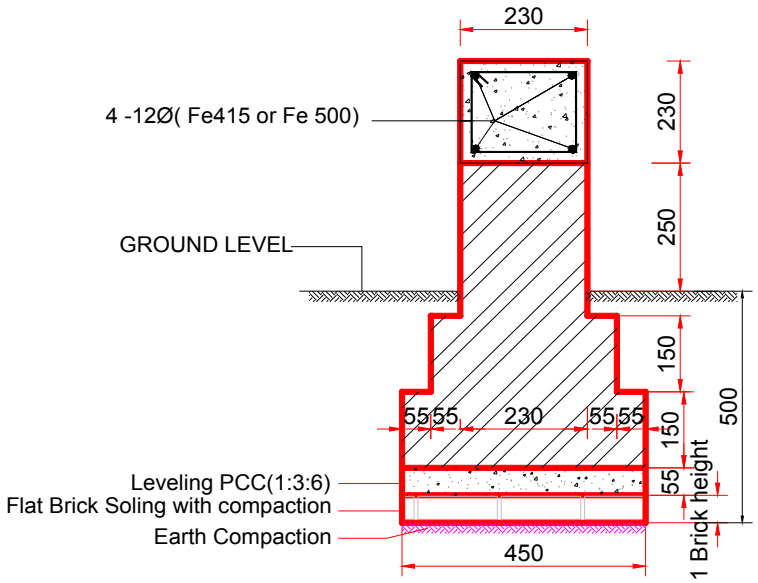


Figure 7.5(a) OPTION-I: Brick Masonry Toe Wall

Toe wall for Hard and Medium type foundation sub grade as defined in Table 3.1

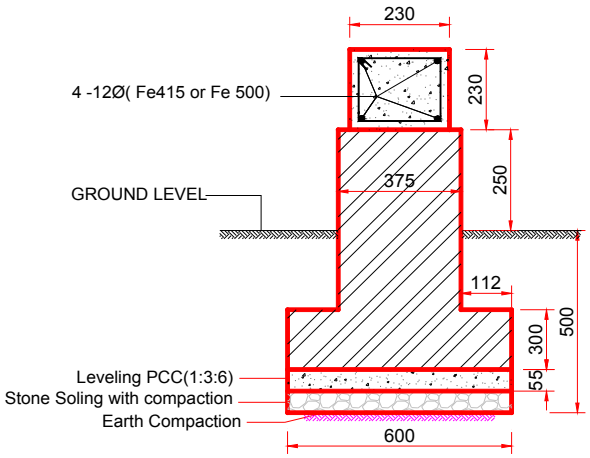


Figure 7.5(b) OPTION-II: Stone Masonry Toe Wall

Toe wall for Hard and Medium type foundation sub grade as defined in Table 3.1

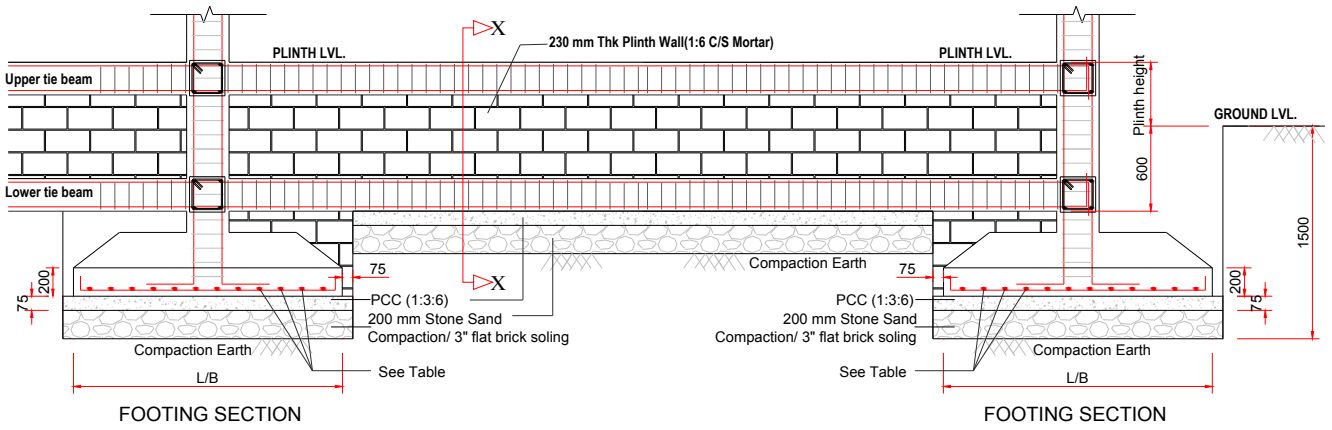


Figure 7.5(c) View of foundation, plinth tie beam, foundation tie beam and toe wall

Plinth wall, lower and upper tie beam option is for Soft and weak soil type as defined in Table 3.1

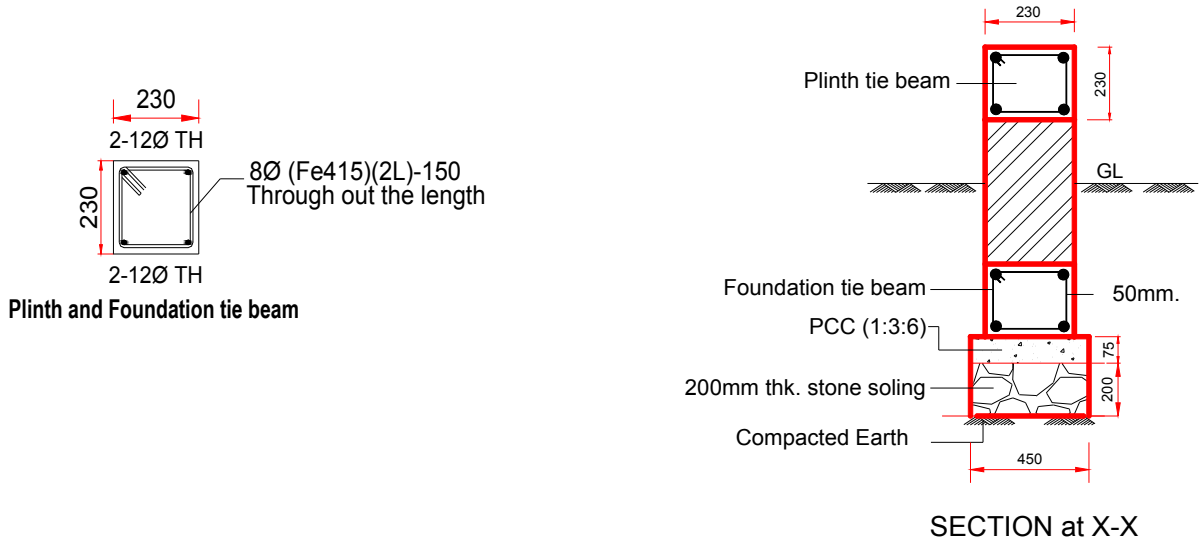


Figure 7.5(d) Typical Details of figure 7.5 (c)

Stair Case:

Staircase should be detailed as in Figure 7.6 given below

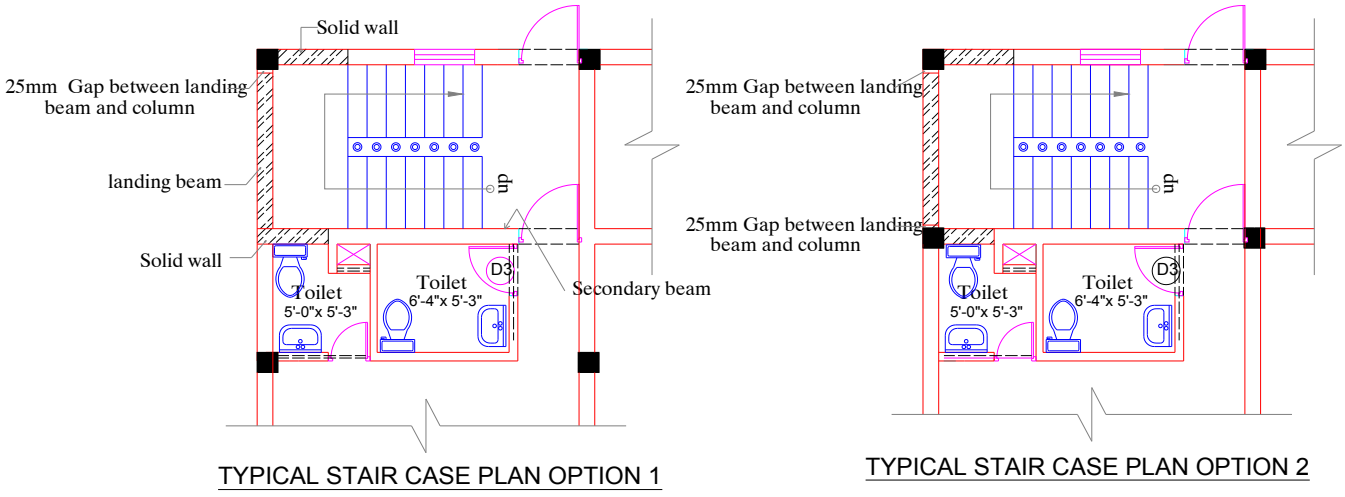


Figure 7.6(a)Staircase Plan

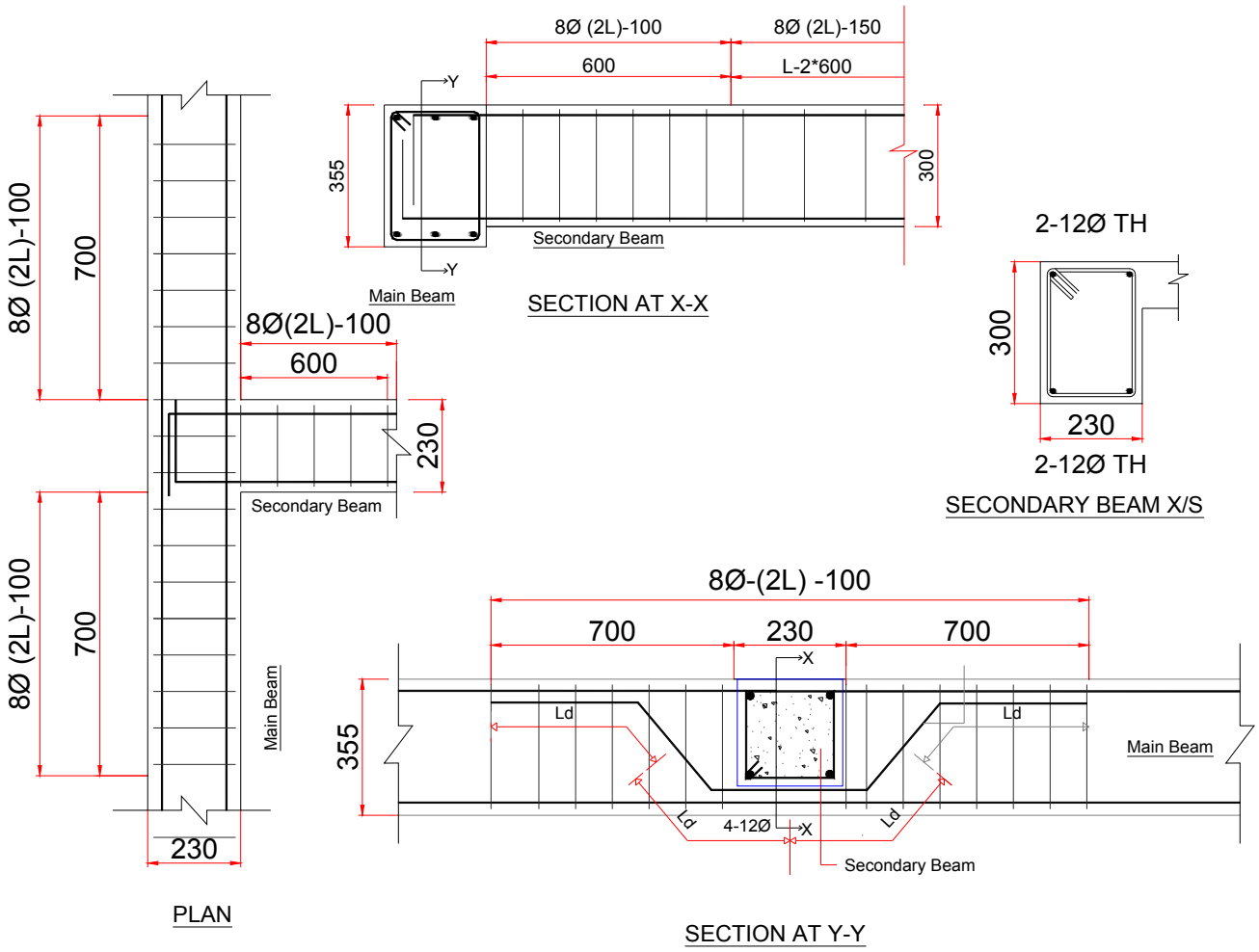
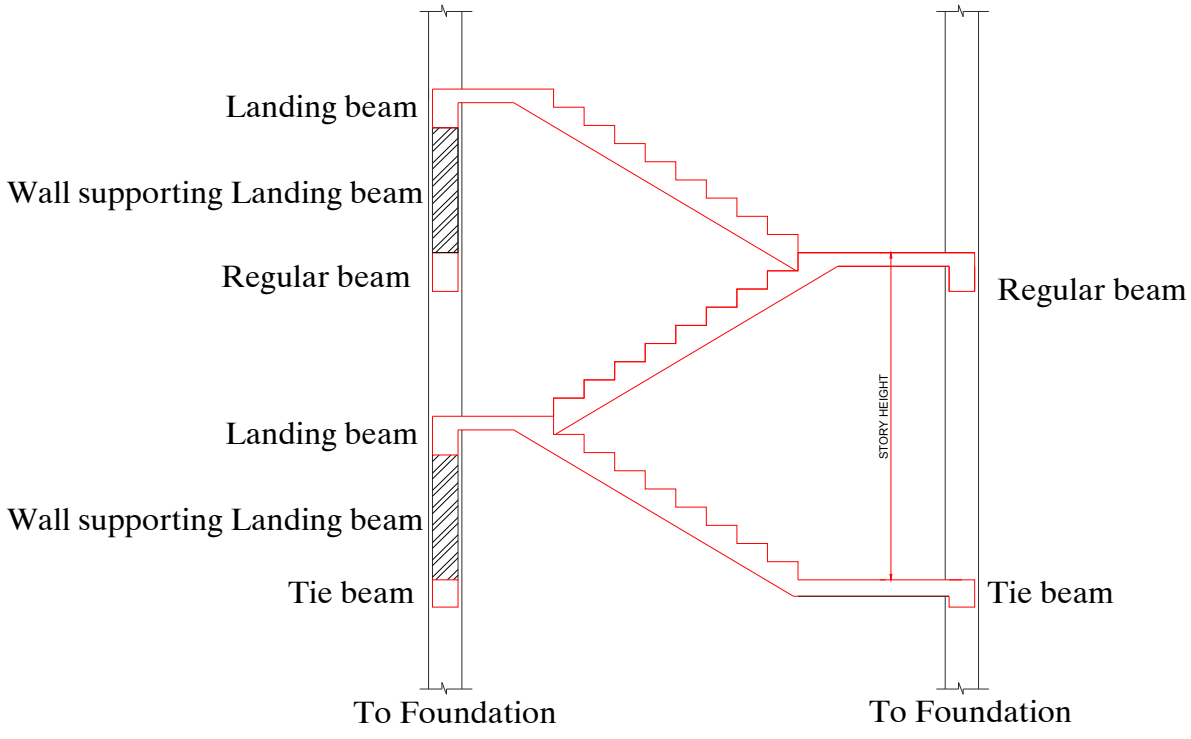


Figure 7.6(b)Typical Detailing for Connection between Main and Secondary Beams



Note: Landing beam should be supported on wall only.
Do not use column near by to support this beam

i) Staircase incline slab depth = 125 mm
ii) Trade and raise size : As per building plan
iii) Width of the staircase flight : 1050 mm

Fig. 7.6(c) Staircase Elevation

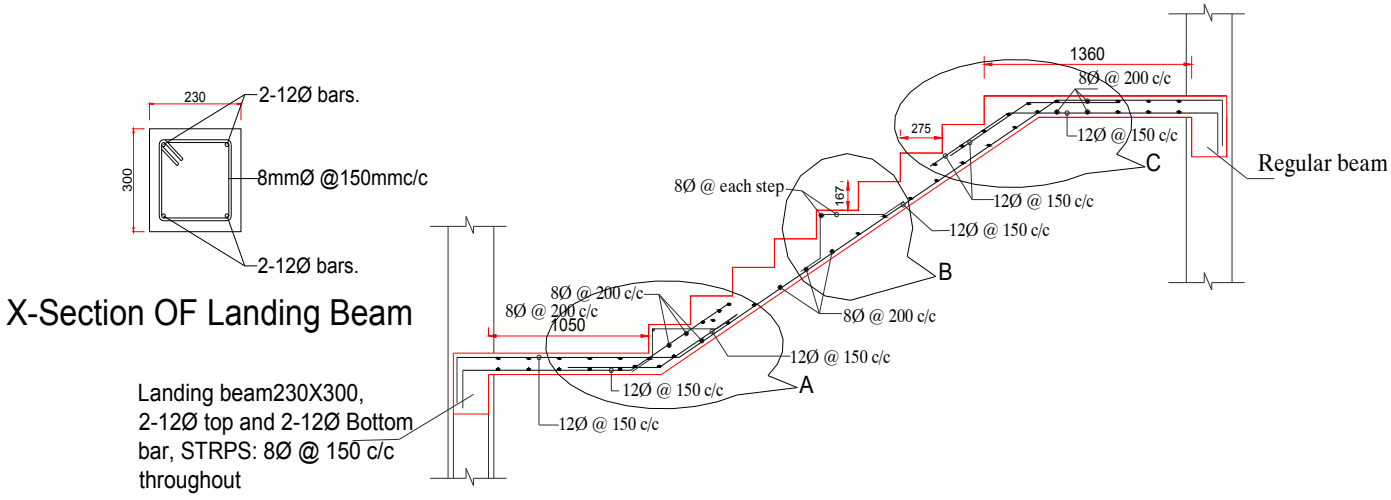


Fig. 7.6(d) OPTION-I:Staircase with RCC waist slab and RCC steps

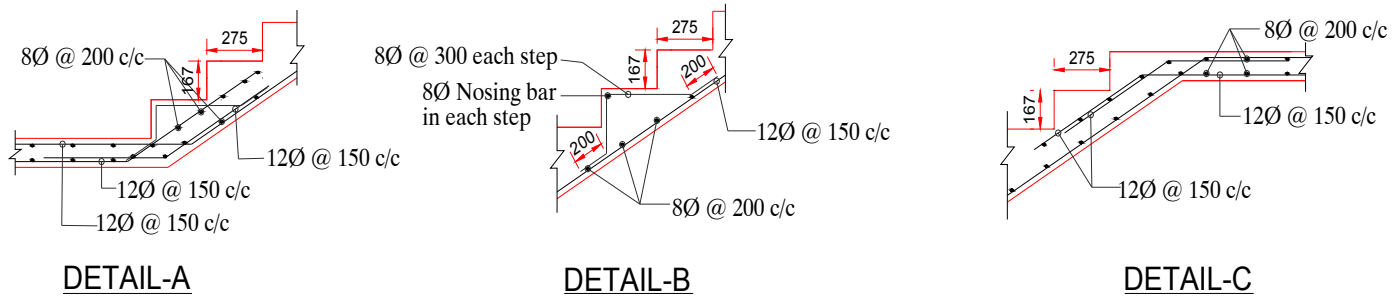


Fig. 7.6(e) Typical Details of staircase RCC waist slab and RCC steps

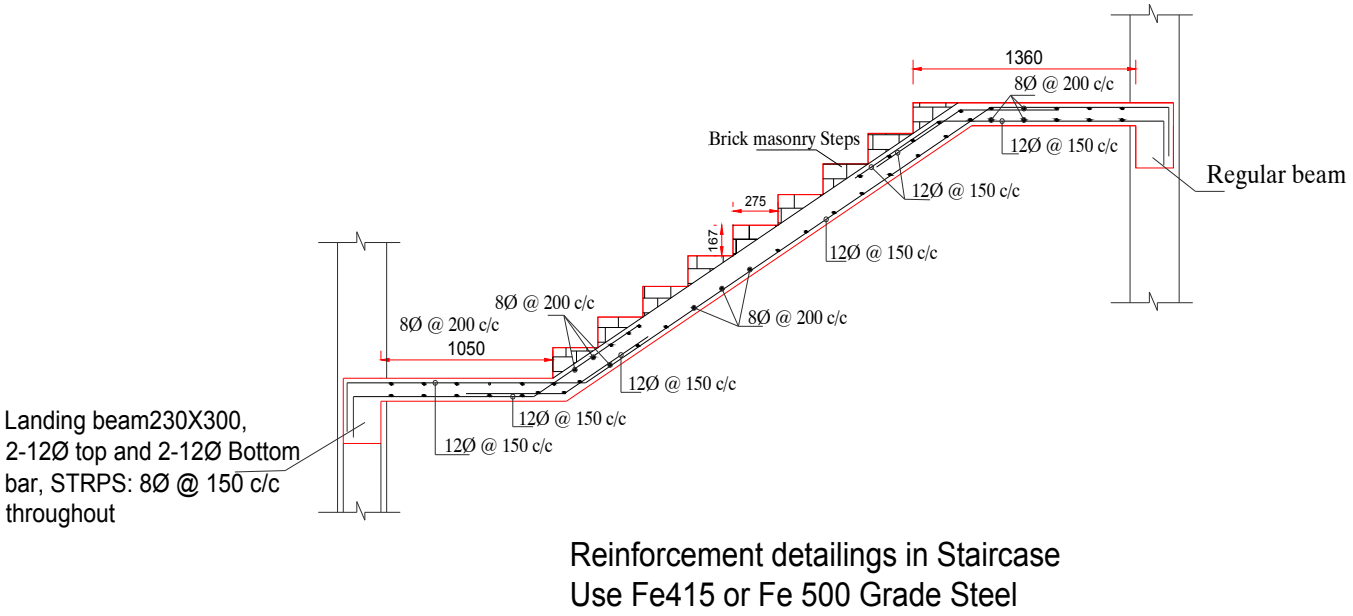


Fig. 7.6(f) OPTION-II: Staircase with RCC waist slab and Masonry steps

8 Reinforcing Non-load Bearing Walls

8.1 Between Framing Columns

8.1.1 Solid Walls

To prevent walls from falling out, these shall be provided with horizontal reinforced concrete (RC) bands through the wall at about one-third and two-thirds of their height above the floor in each storey. The width of the band should be equal to the wall thickness and its thickness equal to 75 mm. Reinforcement details shall be as given in **Figure 8.1.**

Reinforcement:

(a) Longitudinal - two bars 8 mm ϕ (Fe415) or two 7 mm ϕ (Fe500) bars anchored fully in the RC column abutting the wall.

(b) Transverse - links 4.75 mm ϕ (Fe415 or Fe 500) stirrups at every 150 mm.

8.1.2 Walls with Openings

Provide a horizontal RC band through the wall at the lintel level of doors and windows and at window sill level in each storey as given in **Clause 8.1.1.**

Details of the arrangement are given in **Figure 8.2**.

8.2 Outside Framing Columns

A horizontal RC band shall be provided through all walls - one at window-sill level and the other at lintel-level. All details shall be the same as in **Clause 8.1.1** The reinforcement of bands shall be taken through the cross-walls into the RC columns as detailed in **Figure 8.3.**

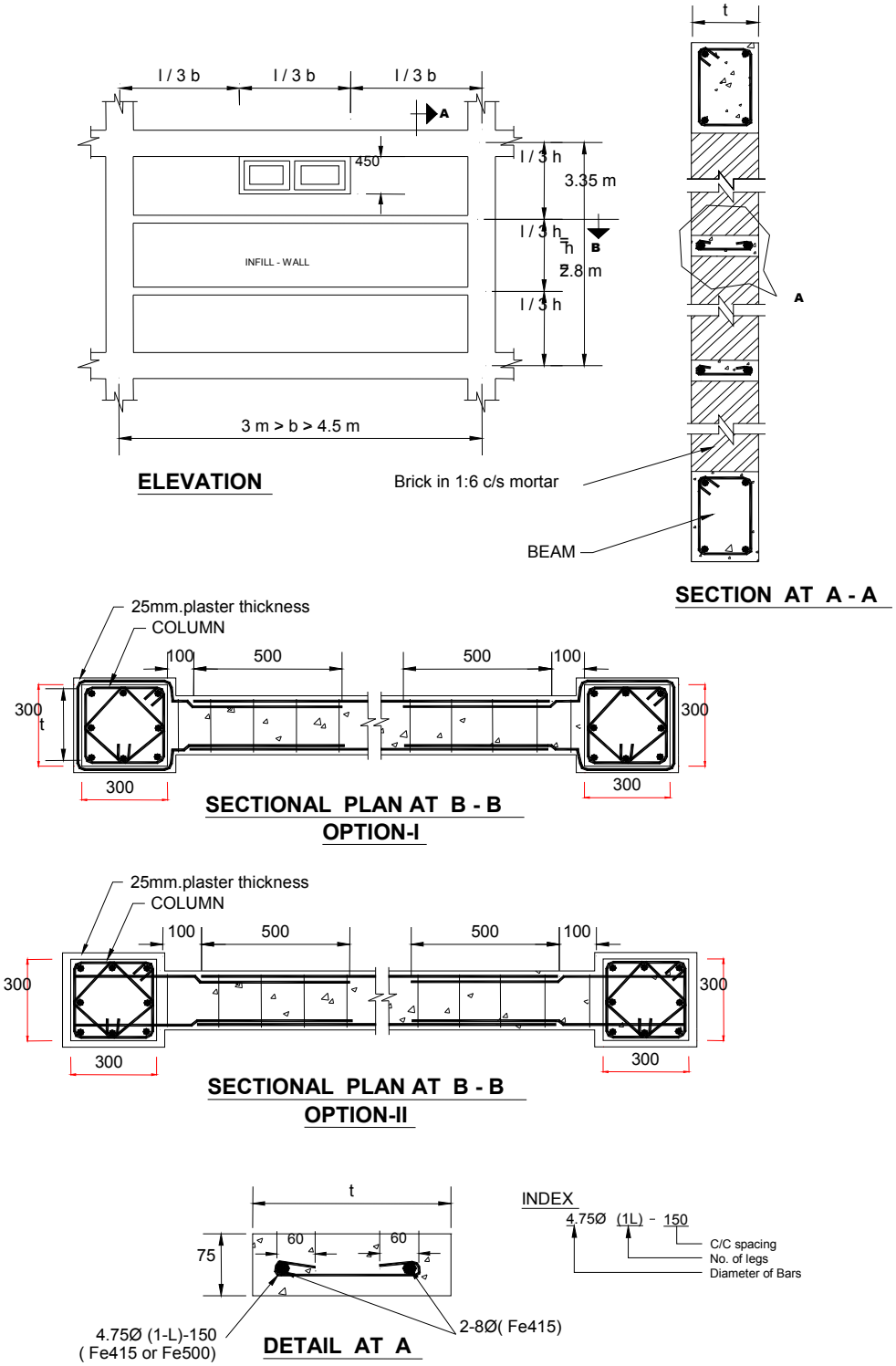
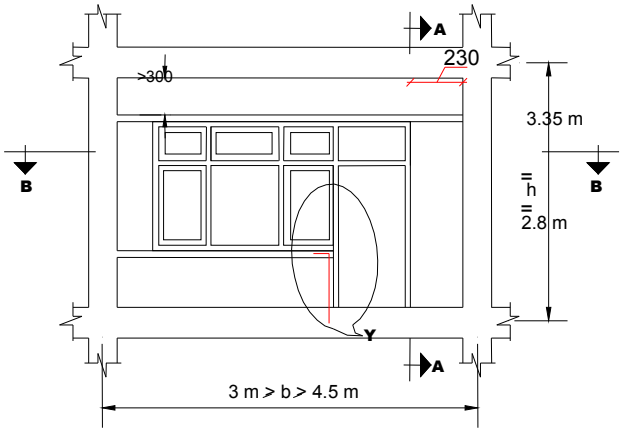
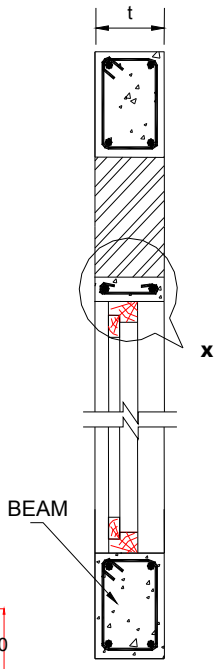


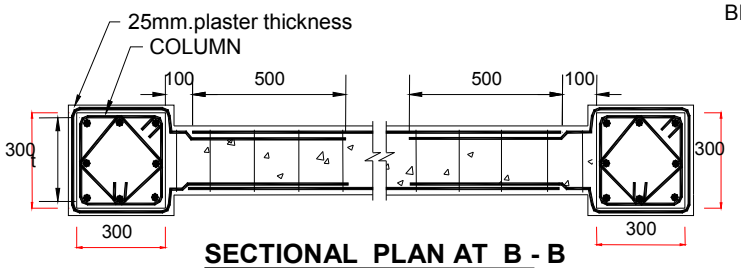
Figure 8.1 **Band Detail of Solid Walls**



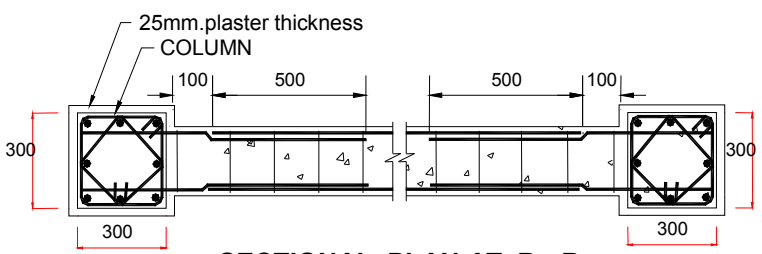
ELEVATION



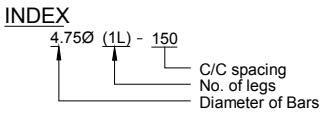
SECTION AT A - A

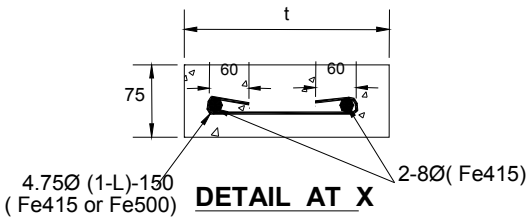


SECTIONAL PLAN AT B - B
OPTION-I

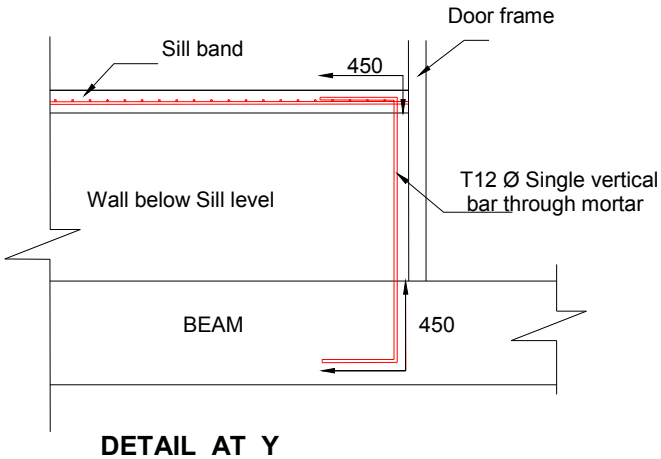


SECTIONAL PLAN AT B - B
OPTION-II





DETAIL AT X



DETAIL AT Y

Figure 8.2 **Band Detail of Solid Walls**

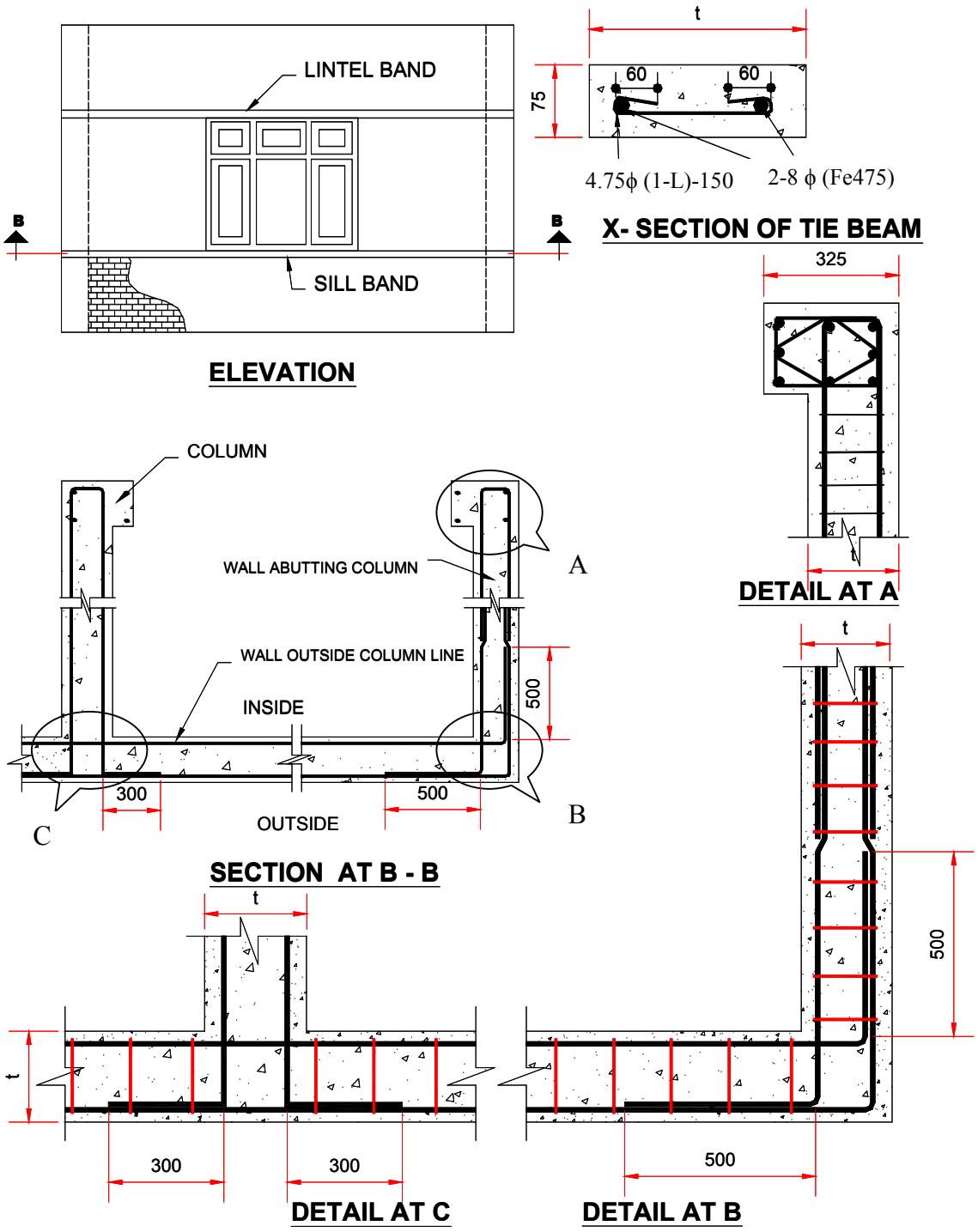


Figure 8.3 : **Wall Outside the Frame**

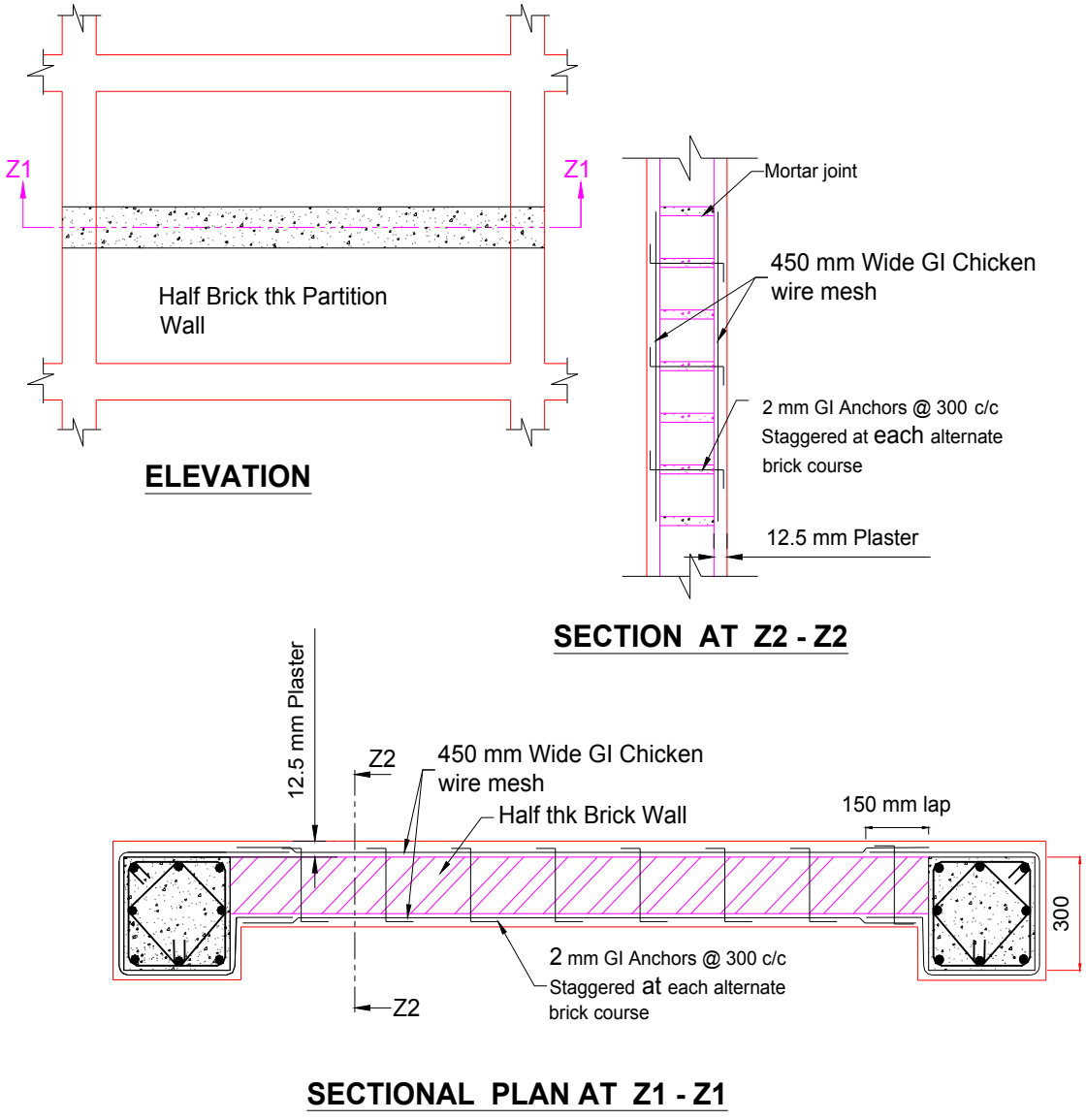


Figure 8.4 :BAND **Detail of Solid Partition Walls**

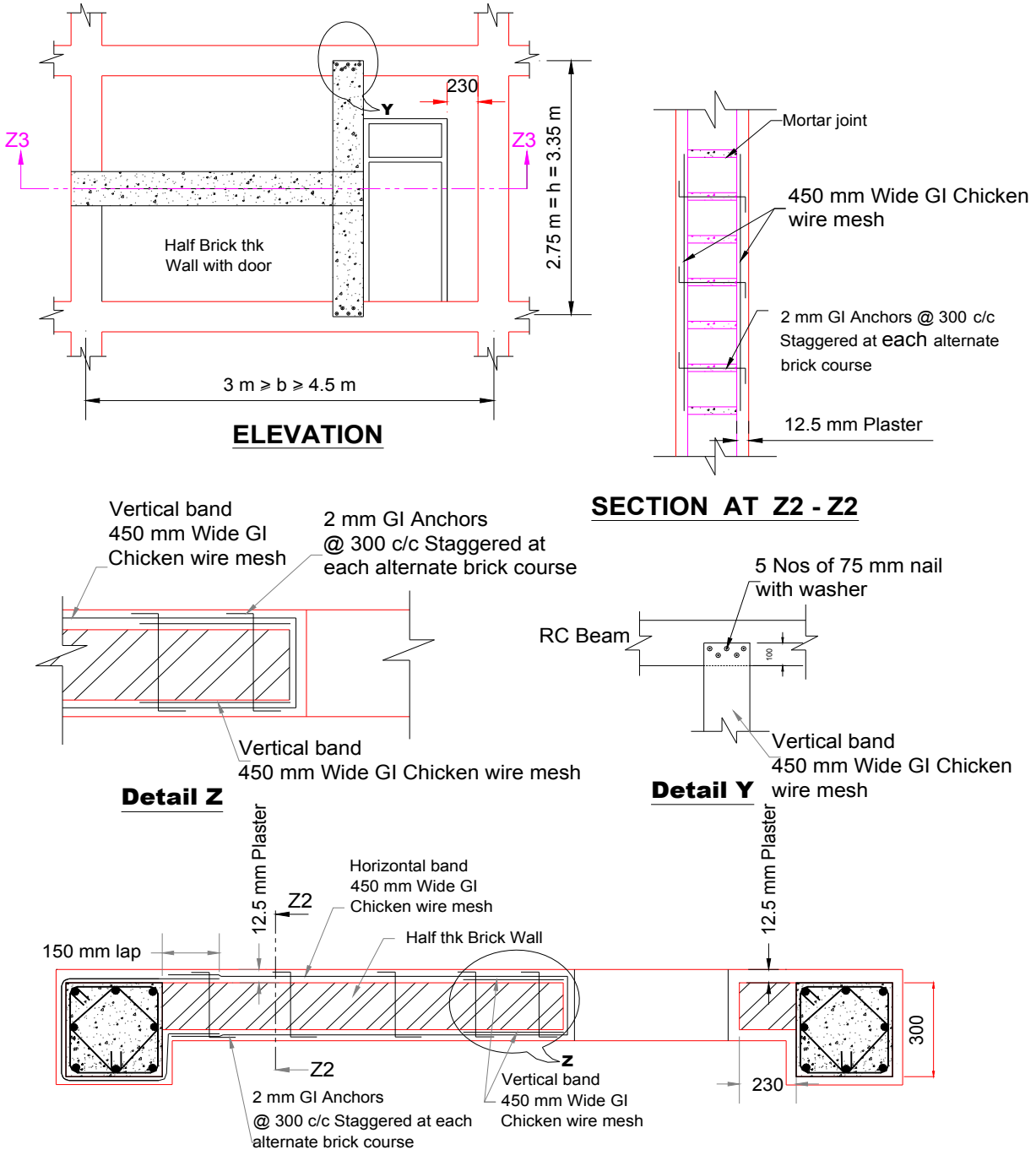


Figure 8.5 :BAND **Detail of Solid Partition Walls**

9 Parapets

9.1 General

Parapets above roofs and at the edges of the balconies shall not be taller than one metre. They should either be constructed in reinforced concrete or be reinforced with vertical RC elements spaced not more than 1.5 m apart. The section of the vertical RC post may be kept to *b* x 75 mm, where *b* is the thickness of the parapet. Such RC elements should be reinforced with two vertical bars of 8 mm diameter steel (grade Fe415)/7 mm Fe 500 with transverse links 4.75 mm ϕ diameter steel (grade Fe415/Fe 500) @ 150 mm centres. The vertical reinforcement shall be tied in the steel of the slab or beam below with a minimum embedment of 300 mm. Also, a handrail should be provided at the top with a section size and reinforcing as explained in **Clause 8.1.1.** For details, refer to **Figure 9.1.**

9.2 Flower Pots

Flower pots should not normally be placed on parapets. However, if it is desired that they be placed there, they shall be adequately wired and held to the parapet through pre-fixed steel hooks/anchors so that they will not be dislodged in severe earthquake shaking.

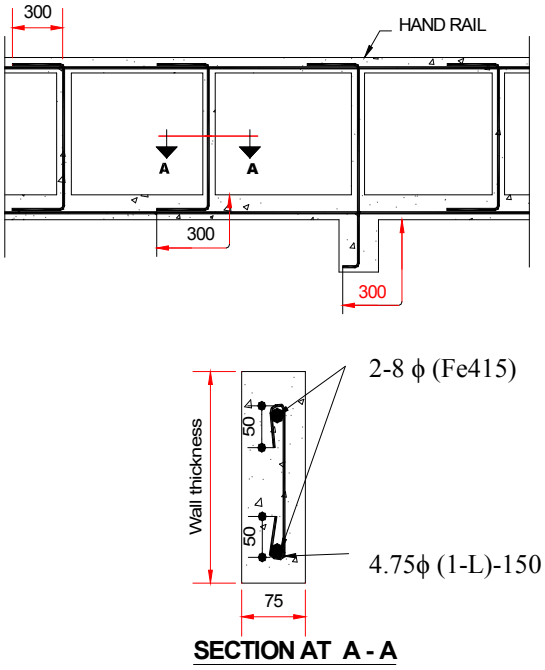


Figure 9.1 : **Parapet Wall Tie-up Details**