

Following are the draft guidelines for Boundary Wall construction. Please send us any comments/ feedbacks.

## Guidelines for Boundary Wall

### Introduction

A boundary wall, here, means any wall, fence or enclosing structure erected on or next to a property boundary. Boundary walls fronting onto public streets are readily visible and hence have direct impact to the character and visual amenity of the neighborhoods. Besides providing security and privacy, they are also a vital component for enhancing the appearance of the locality and its streetscape. Further, the recent experiences show that the boundary walls are related with the safety issue of street users which is especially true for a high seismic zone country like Nepal.

### Existing by-law of KMC on Boundary wall

#### ९.१३ सीमा पर्खाल (Boundry wall)

सीमा पर्खालको निमित्त निम्न व्यवस्था लागू हुनेछ :

- (क) सीमा पर्खाल (Compound wall) को उचाई बाटोको केन्द्र रेखाबाट बढीमा १.५ मी हुनु पर्नेछ । स्थानीय निकायको स्वीकृति लिएर २.१ मी. सम्म उचाई भएको सीमा पर्खाल लगाउन सकिनेछ तर यस्तो पर्खालको माथिल्लो ०.६ मी. खुला किसिमले बनाउनु पर्नेछ ।
- (ख) माथि (क) मा उल्लेखित व्यवस्था जेलहरुको निमित्त लागू नहुने र औद्योगिक भवन निर्माण, विद्युत् सब स्टेशनहरु, ट्रान्सफर स्टेशनहरु, शैक्षिक भवनहरु वा अन्य सार्वजनिक रुपमा प्रयोग हुने भएमा स्थानिय निकायले बढीमा २.४ मी. सम्मको उचाईलाई स्वीकृति दिन सक्नेछ ।

Translation of Existing by-law on Boundary wall:

- Height of the boundary wall measured from the center line of the road as the benchmark should be maximum 1.5 meters (5 feet). It can be up to 2.1 meters (7 feet) if permitted by the local agency; however, its upper 0.6 meter (2 feet) portion should be built transparent or view fencing in nature.
- Above mentioned law is not applicable for the high security needed building uses such as a jail. The concerned local body can permit the height of boundary wall up to 2.4 meters (8 feet) for industrial buildings, electric substations, transfer stations, educational buildings or other similar public buildings.

### Existing conditions

As mentioned above, KMC has specific by-laws on Boundary wall design; however, its enforcement remains ineffective or ignored on any type of streets. Solid boundary walls having height much more than permitted by the by-law have increased physical and social risks for the street users particularly pedestrians. A recent April 25<sup>th</sup> 2015 earthquake has clearly demonstrated the violence of the by-law and fault in construction of these boundary walls as many of these walls were seen collapsed by the shaking with some cases involving the casualties and death of civilians.

Moreover, boundary walls with variegated forms, colors, materials and unfinished surface have diminished the visual appearance of neighborhood's streetscape, and the addition of barbed wire and glass shards on the wall has made scenario even more chaotic.

These are a few examples of existing boundary walls.





## Objectives

The followings are the objectives of the guidelines:

- a) To establish standards, and regulations concerning the appearance of neighborhood as a general public amenity.
- b) To ensure the safety of pedestrians and other street users.
- c) To provide opportunities for passive surveillance of the public realm from private residences in the surrounding.
- d) To promote a pedestrian-friendly environment.
- e) To protect and enhance the aesthetic amenity and characters of neighborhoods, wards and streets, while developing individual or institutional buildings and premises.

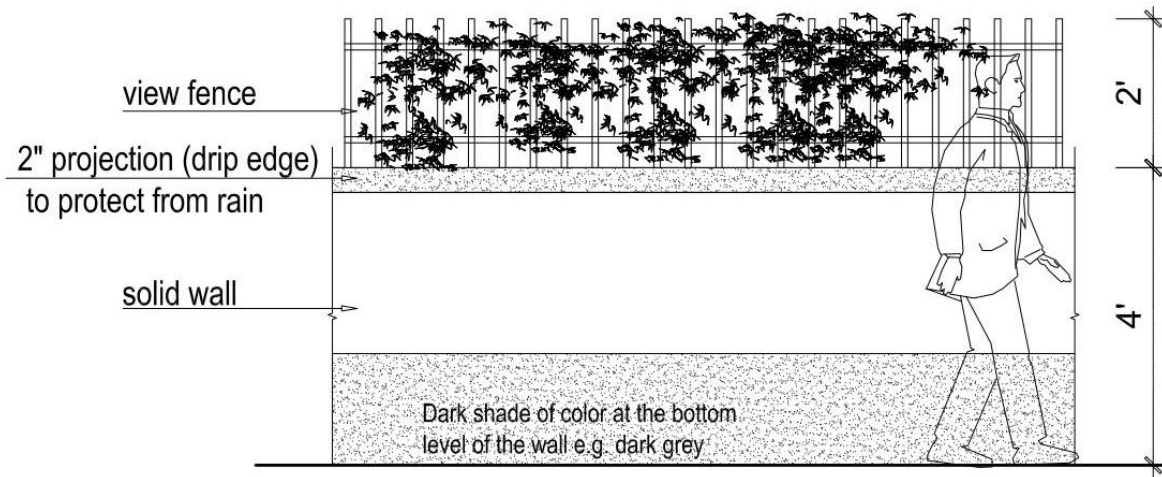
## Design

The guidelines propose following design considerations.

- Boundary wall along the road can have maximum height of 1.8 meters (6 feet), as shown in the figure 1, in which maximum 1.2 meters (4 feet) of its lower portion should be solid whereas upper portion needs to be in the form of view fencing.
- In case of government and public properties, boundary wall along the road can have maximum of 0.9 meter (3 feet) solid lower portion whereas its upper portion needs to be view fence.
- The height of wall shall be measured from the level of the pavement (footpath) and in the absence of a pavement, from the natural level of the ground outside the property immediately

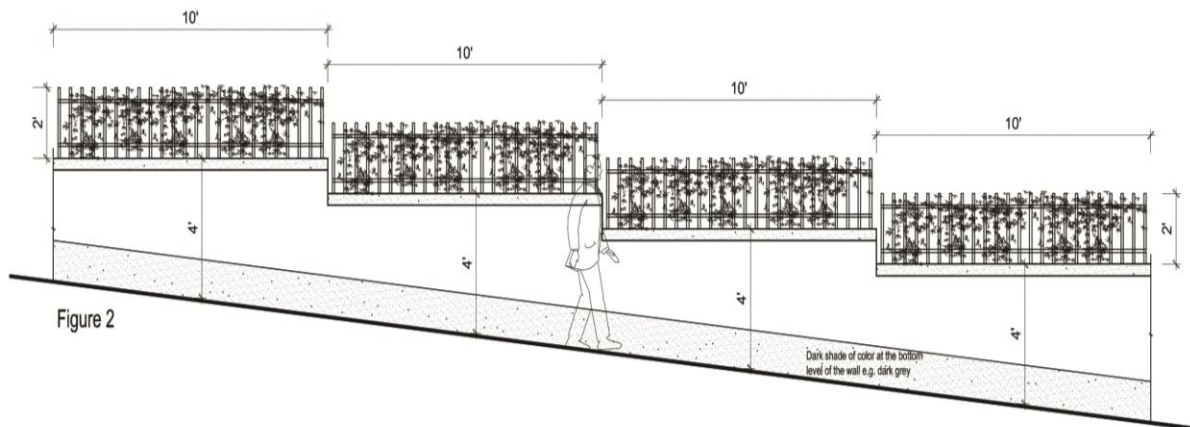


adjacent to the wall.



*Figure 1*

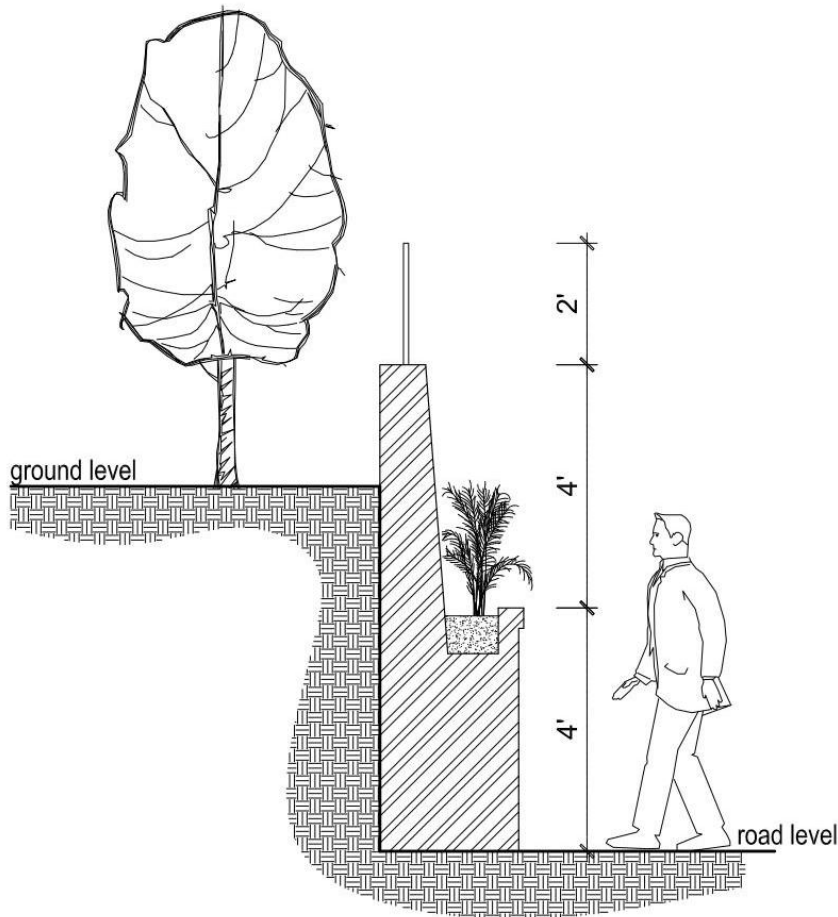
- Side and rear boundary wall can have maximum height of 6 feet, which may not have view fence.
- The boundary wall along the slope road, as shown in figure 2, can be constructed in stepped design of equal divisions. Each division should follow the height requirements as shown in figure 1.



*Figure 2*

- If the road level is more than 1.2 meters (4 feet) lower than the ground level of the property, as shown in figure 3, the boundary wall should have provision for vegetation along the wall at each 1.2 meters (4 feet) level from the road. It is property owner's responsibility to construct such space along the wall, plantation of plants and their take care. Such boundary wall may require weep holes and other provision to drain out the water.





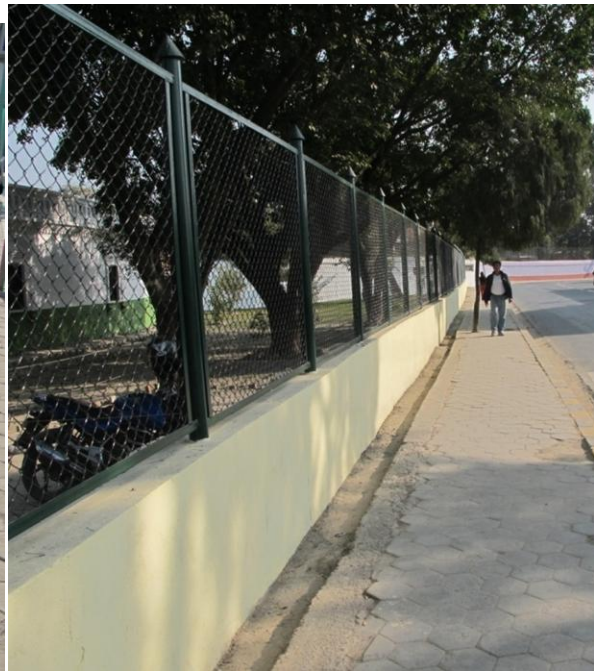
*Figure 3*

- The boundary wall at the turnings of the road should not obstruct the sight distance of vehicles.
- The property owner should take responsibility of any mishaps caused by unsafe, weak and old boundary wall structure. Moreover, the local agency can make the property owner to demolish and reconstruct such old and unsafe boundary walls.
- The boundary wall should be safe and stable with proper structure design, as shown in Annex. Alternatively the boundary wall could be designed by a structure engineer registered with Nepal Engineer's Council and reviewed by the especial review committee or organizations recommended by the government. This second rule is applicable for unique cases of wall designs differing in site conditions.
- For special buildings uses other than mentioned here, design of the boundary wall should be approved by the concerned municipalities.

## Appearance

- Street side boundary wall should appear as an integral part of the streetscape and should not dominate or detract from the overall streetscape appearance.
- Boundary wall color should relate to the building it belongs to, and be complementary to adjacent boundary wall color, style and material.
- As shown in figures above, the boundary wall should have the drip edge and lower portion of the wall should be in dark color.
- Use of barbed wire, glass shards and other materials that ruins the appearance should not be permitted to use on the boundary wall unless permitted by the local agency.

**Few good examples of boundary wall are as follows:**







## General Structural Norms for Boundary Wall Construction

The structural design of the boundary wall should be based on relevant standards taking into account of seismic forces based on seismic zone, soil type, and other related factors or design provided in appendix of this guideline could be adopted as per site conditions such as soil type, seismic zone, water table, local materials, terrain and other related factors.

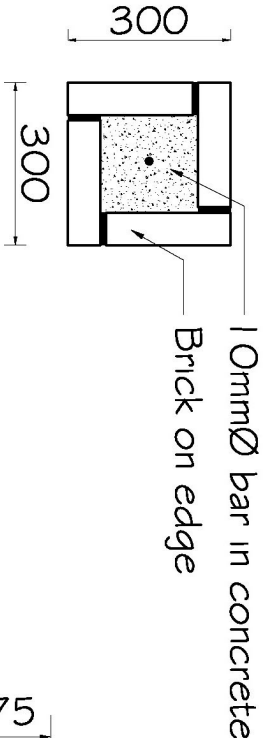
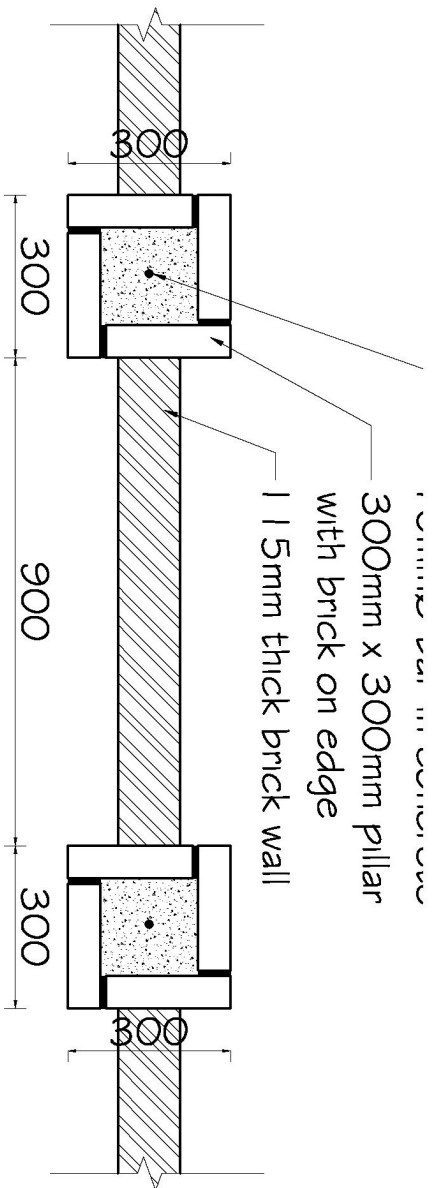
### A) One Half Brick Boundary Wall Construction (solid wall height < 4 feet):

- Maximum height of wall could be upto 1.2 meters (4 feet) and includes 75 millimeters (3 inches) of R.C.C. band on top. The band should consist of two numbers of 8 millimeters diameter reinforcement bars with stirrups of 6 millimeters diameter spaced at 150 millimeters (6 inches).
- Vertical reinforcement bar of 10 millimeters diameter should be provided at maximum spacing of 1.2 meters (4 feet).
- One 10 millimeters reinforcement encased in M15 grade concrete should be provided at maximum of 1.2 meters (4 feet) to support the wall. Vertical reinforcement bar is fixed in M 15 concrete mix.
- Foundation should be at least 600 millimeters (2 feet) deep which includes brick footing of 200 millimeters (8 inches) deep and 460 millimeters (1 foot 6 inches) wide. The footing consists of 75 millimeters (3 inches) horizontal R.C.C. tie band.
- Ratio of cement mortar used for masonry should be 1:4 cement sand mortar.
- View fencing of less than 600 millimeters (2 feet) can be installed on top of this solid brick masonry wall with its supporting posts directly aligned with the vertical reinforcement bars.
- It is recommended to plaster the top R.C.C. band with wall coping at its end.

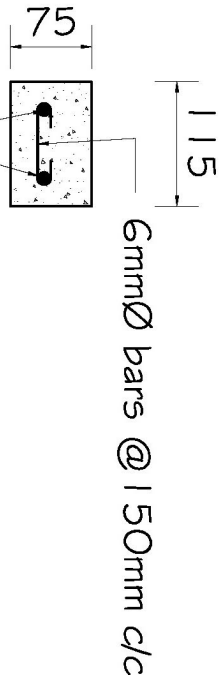
**Note:**

Concrete grade: M15

Cement mortar ratio : 1:4

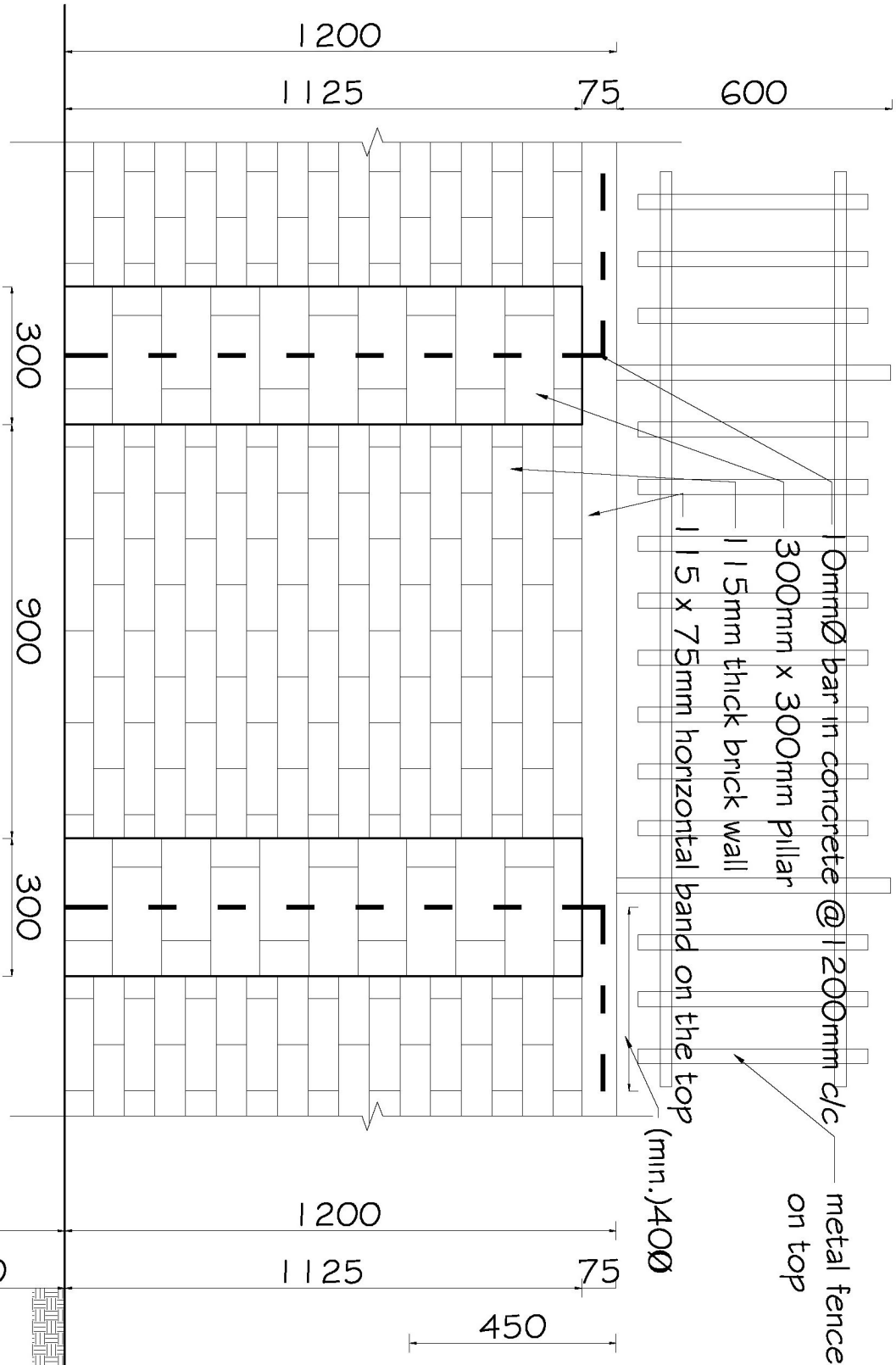


**Brick Pier Plan View**

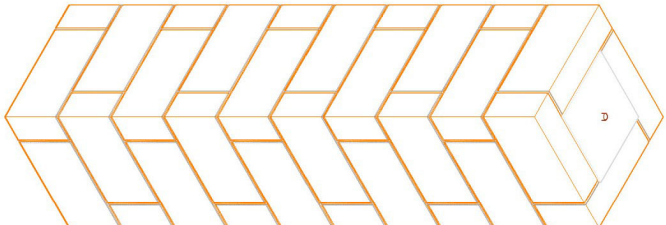


2-8mm $\varnothing$  bars

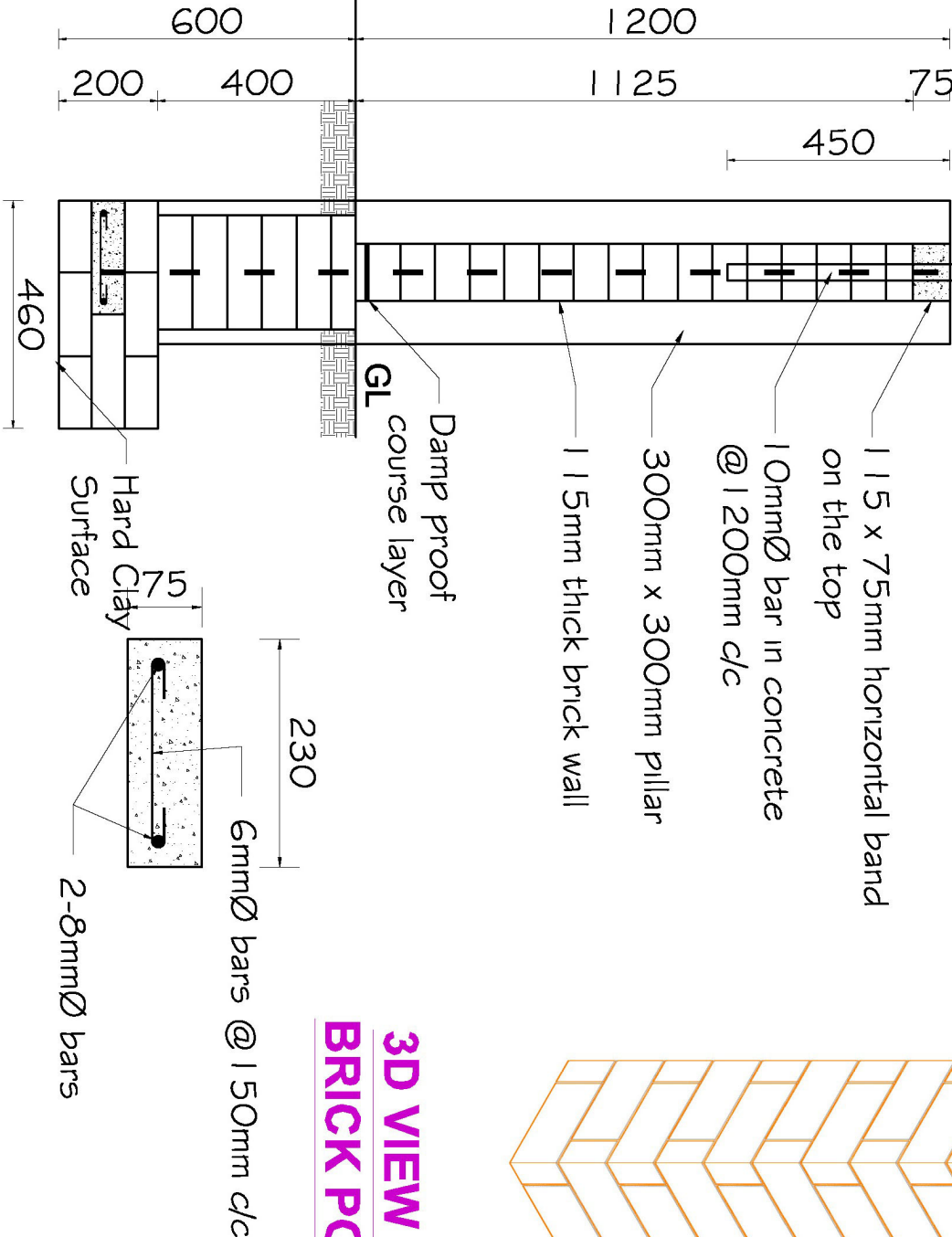
**Plan View**



**HORIZONTAL BAND**



**3D VIEW OF BRICK POST**



**FOUNDATION BAND**

**115 mm thick Solid Brick Wall**

**BOUNDARY WALL (HALF BRICK THICK)**

B) One Full Brick Boundary Wall Construction (solid wall height < 5 feet):

- Maximum height of wall could be upto 1.5 meters (5 feet) and includes 75 millimeters (3 inches) of R.C.C. band on top, however the recommended height is 1.2 meters (4 feet) for street beautification. The band consists of two numbers of 8 millimeters diameter reinforcement bars with stirrups of 6 millimeters diameter spaced at 150 millimeters (6 inches).
- Vertical reinforcement bar of 12 millimeters diameter should be used and be spaced at maximum spacing of 1.8 meters (6 feet).
- One 12 millimeters reinforcement encased in M15 grade concrete should be provided at maximum of 1.2 meters (4 feet) to support the wall. Vertical reinforcement bar is fixed in M 15 concrete mix.
- Foundation should be at least 600 millimeters (2 feet) deep which includes brick footing of 200 millimeters (8 inches) deep and 460 millimeters (1 foot 6 inches) wide. The footing consists of 75 millimeters (3 inches) horizontal R.C.C. tie band.
- Ratio of cement mortar used for masonry should be 1:4 cement sand mortar.
- View fencing of less than 600 millimeters (2 feet) can be installed on top of this solid brick masonry wall with its supporting posts directly aligned with the vertical reinforcement bars.
- It is recommended to plaster the top R.C.C. band with rain drip at its end.

C) One Hollow Concrete Block Boundary Wall Construction (solid wall height < 5 feet):

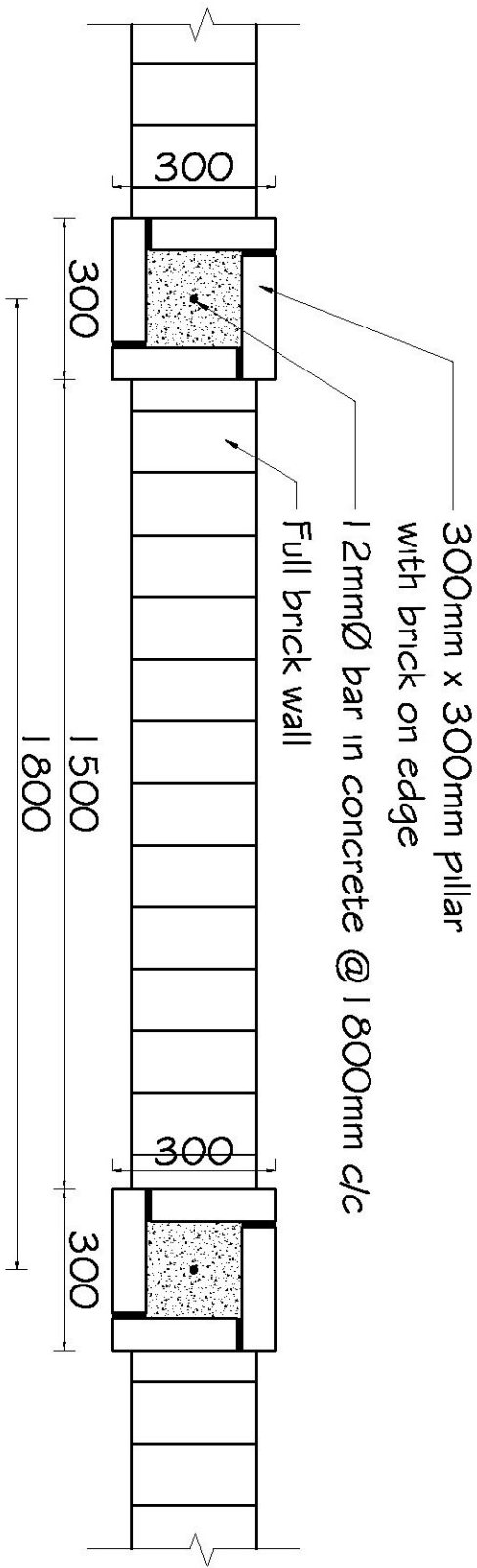
- Construction Technology is similar to the one full brick boundary wall construction. See the drawing below.



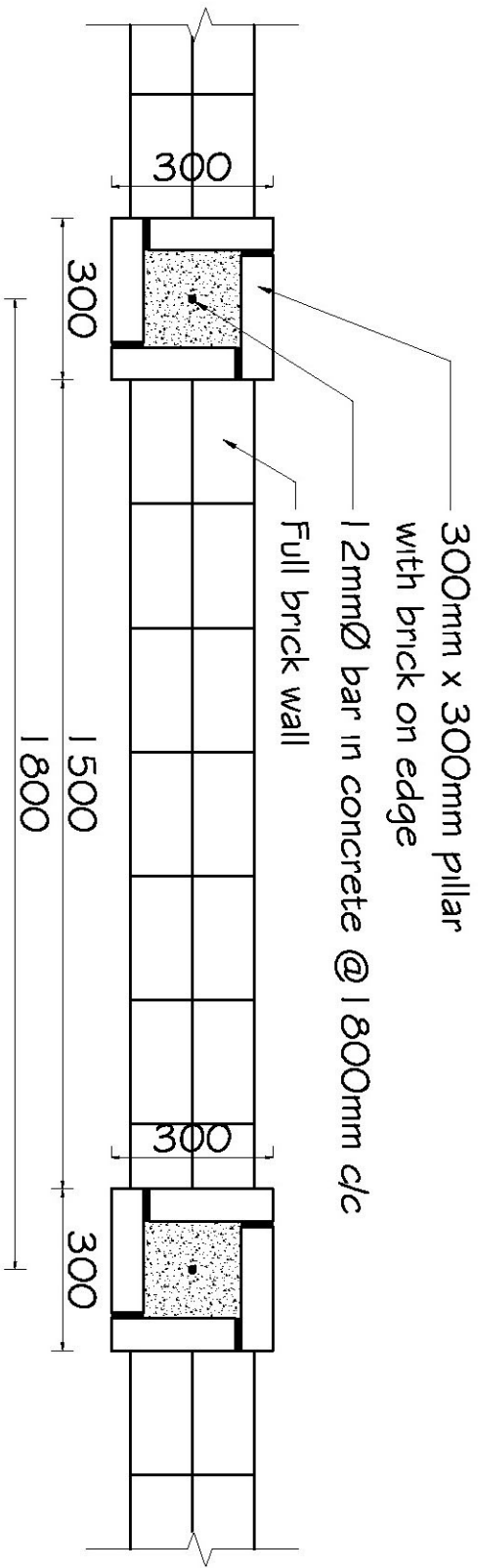
**Note:**

Concrete grade: M15

Cement mortar ratio : 1:4

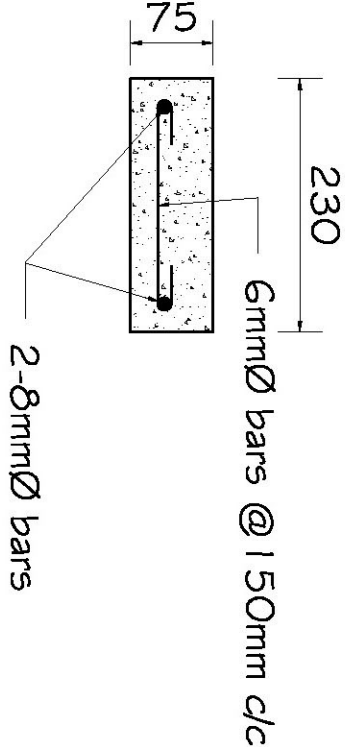


**SECOND LAYERS OF BRICK**



**FIRST LAYERS OF BRICK**

**BOUNDARY WALL**  
**(FULL BRICK THICK)**



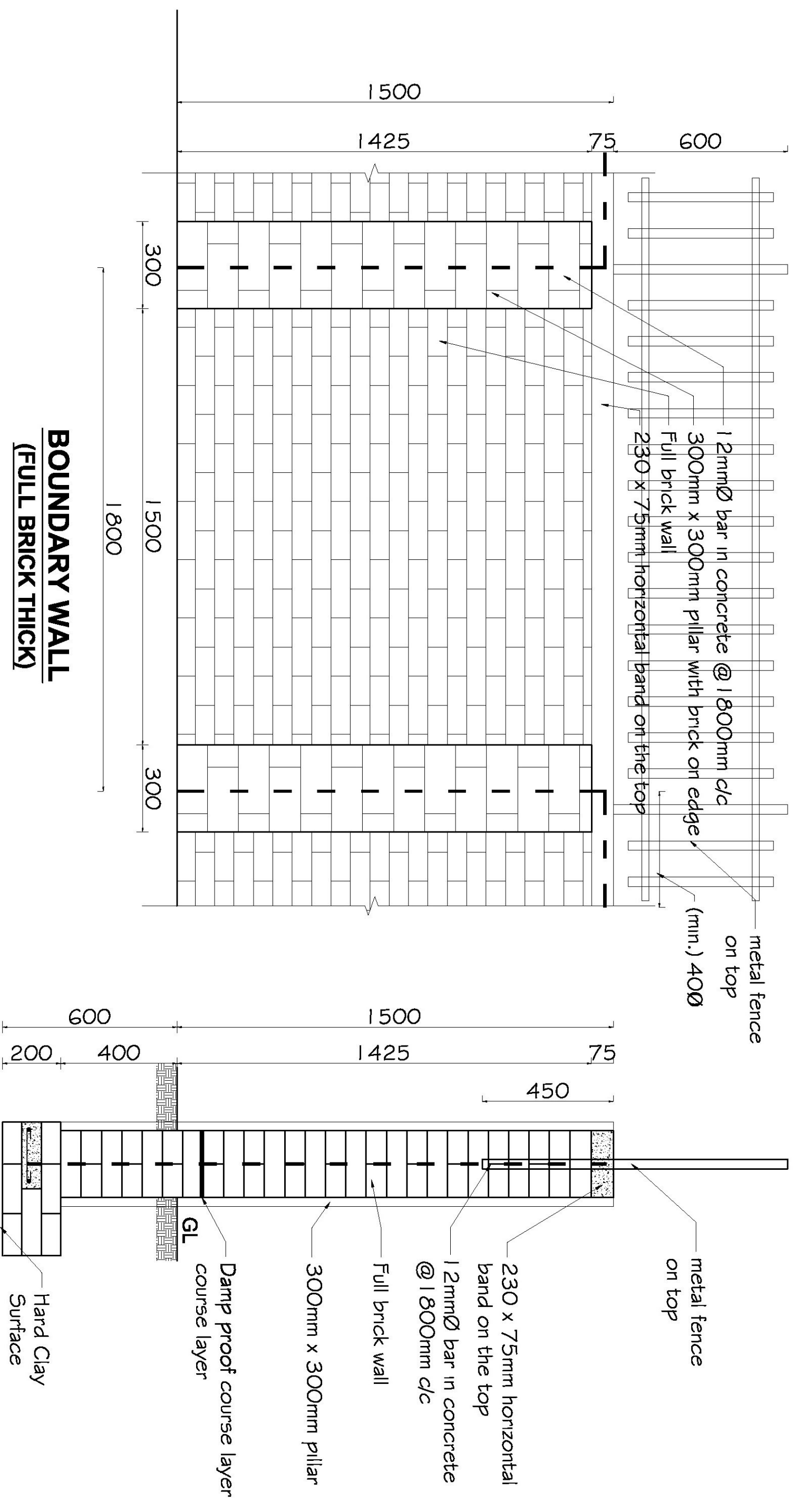
**HORIZONTAL/FOUNDATION BAND**

**Option-1: 230 mm thick solid wall**

**Note:**

**Concrete grade: M15**

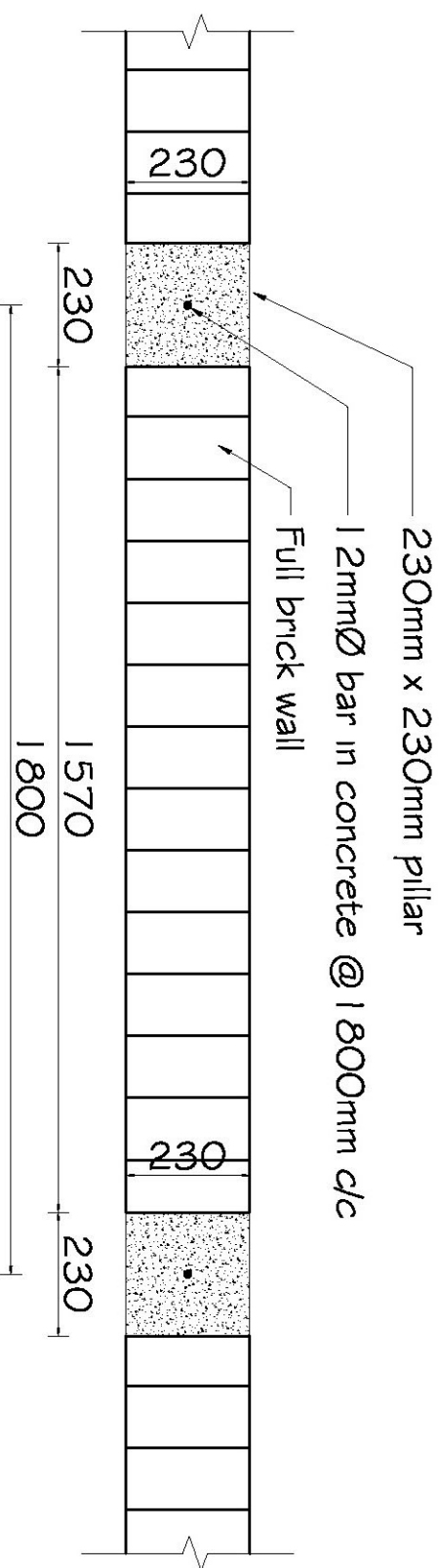
**Cement mortar ratio : 1:4**



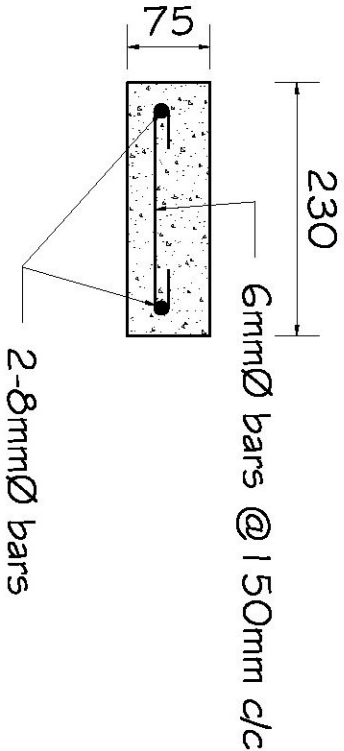
## BOUNDARY WALL SECTION

**Option-1: 230 mm thick solid wall**

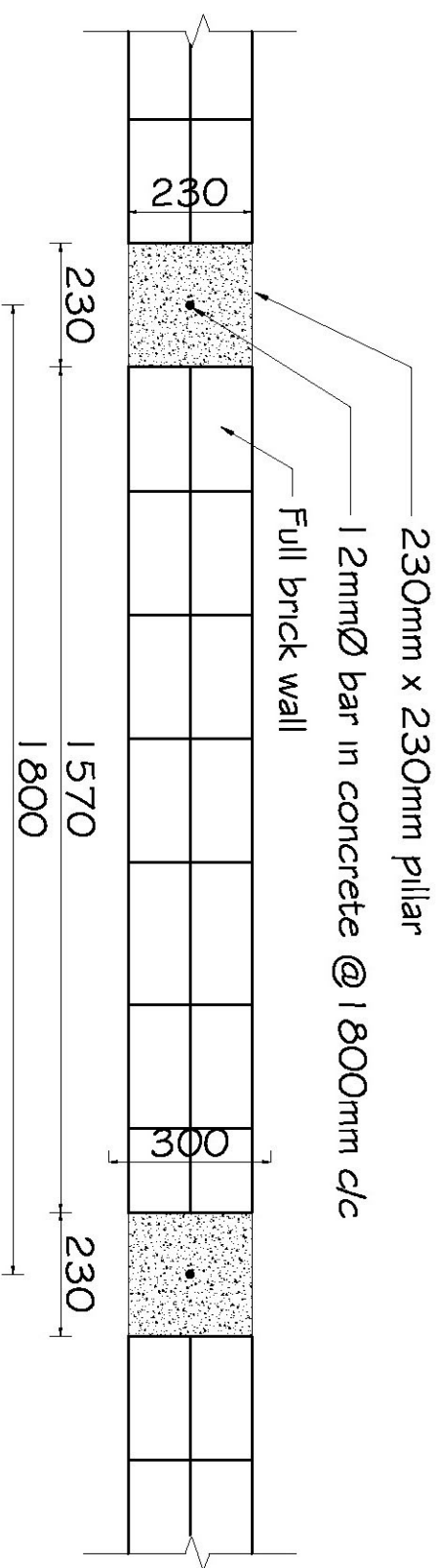
**Note:**  
Concrete grade: M15  
Cement mortar ratio : 1:4



**SECOND LAYERS OF BRICK**



**HORIZONTAL/FOUNDATION BAND**



**FIRST LAYERS OF BRICK**

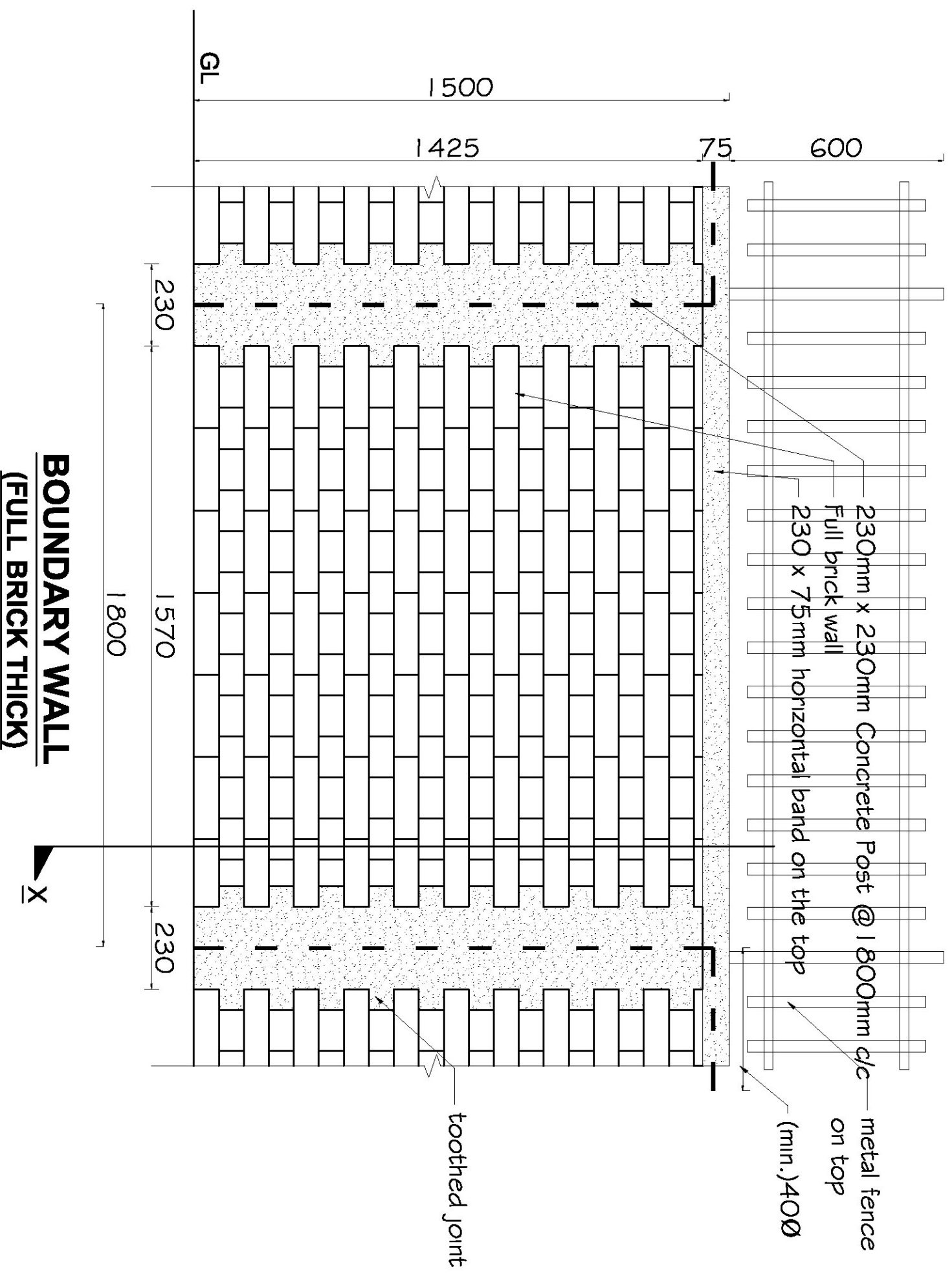
**Option-2: 230 mm thick solid wall  
with 230mm X 230mm pillar**



**Note:**

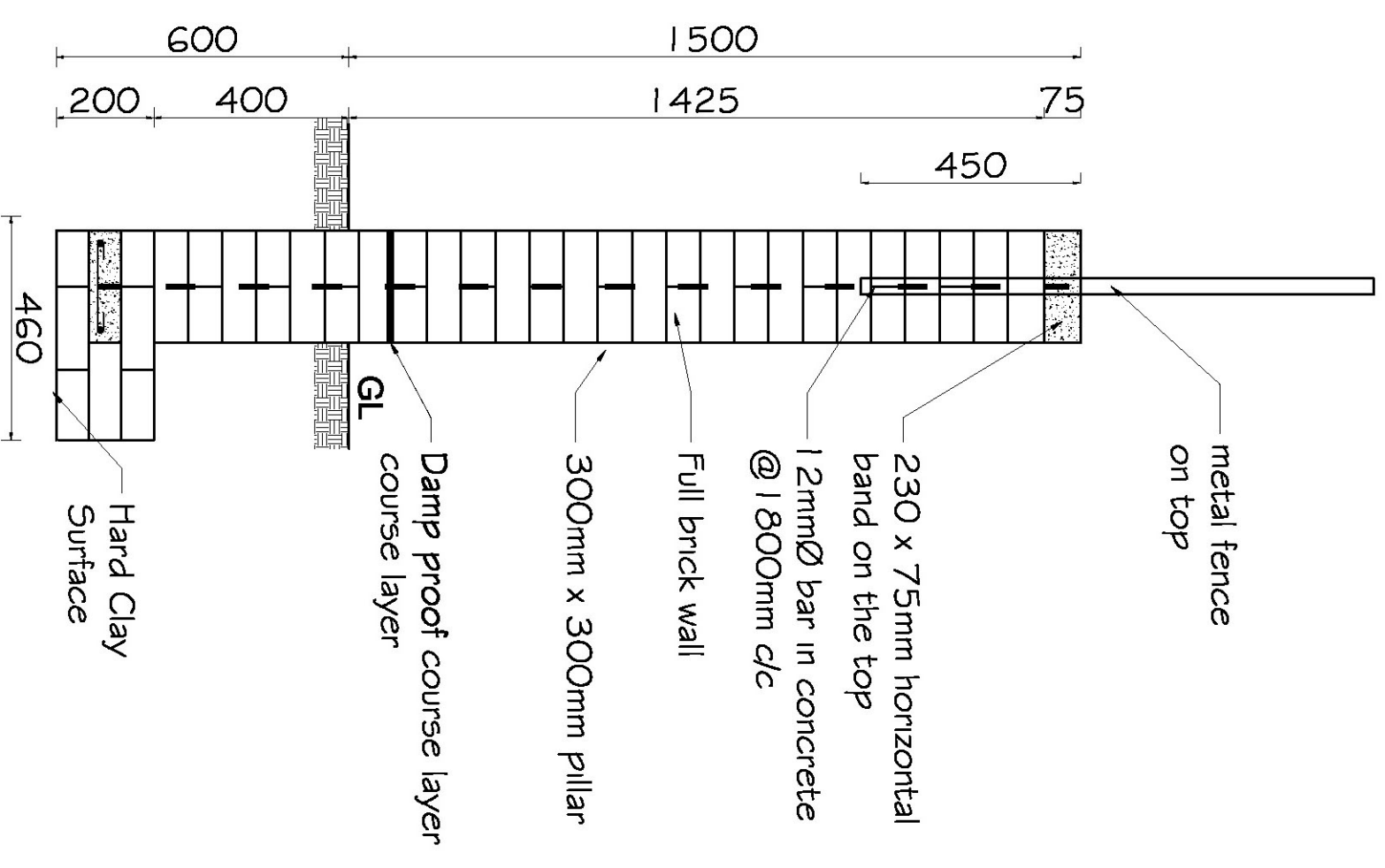
**Concrete grade: M15**

**Cement mortar ratio : 1:4**

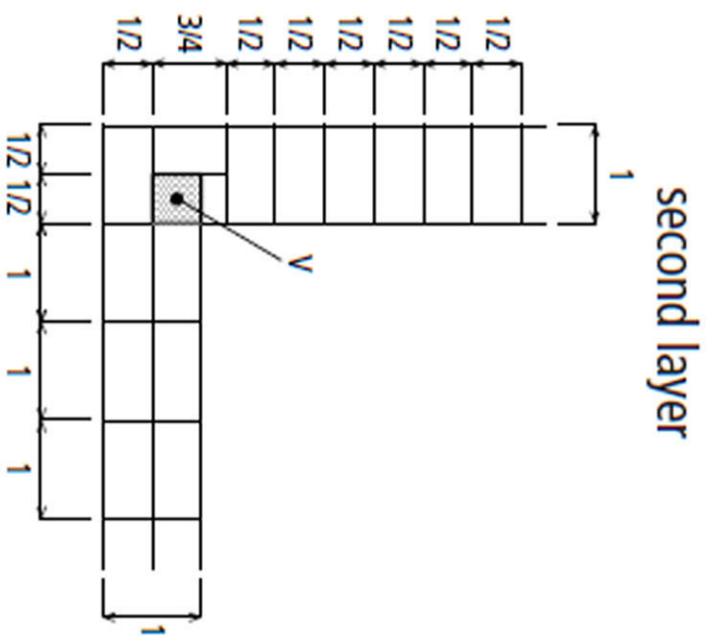
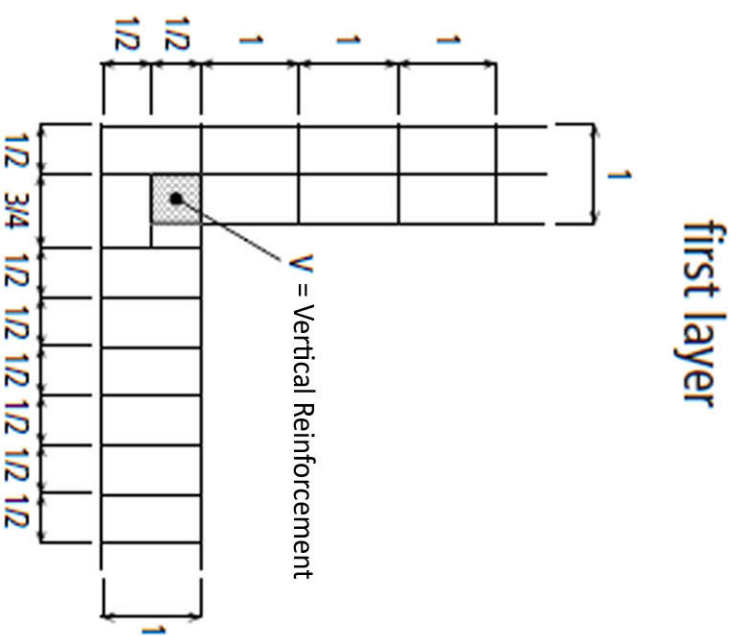


## BOUNDARY WALL SECTION

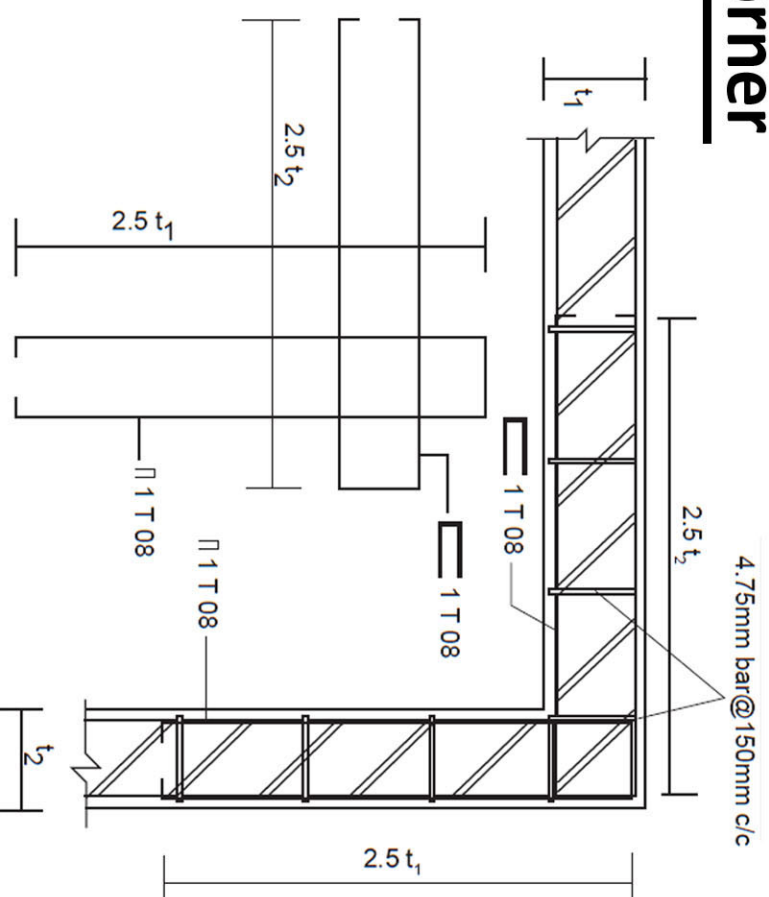
**Option-2: 230 mm thick solid wall with 230mm X 230mm pillar**



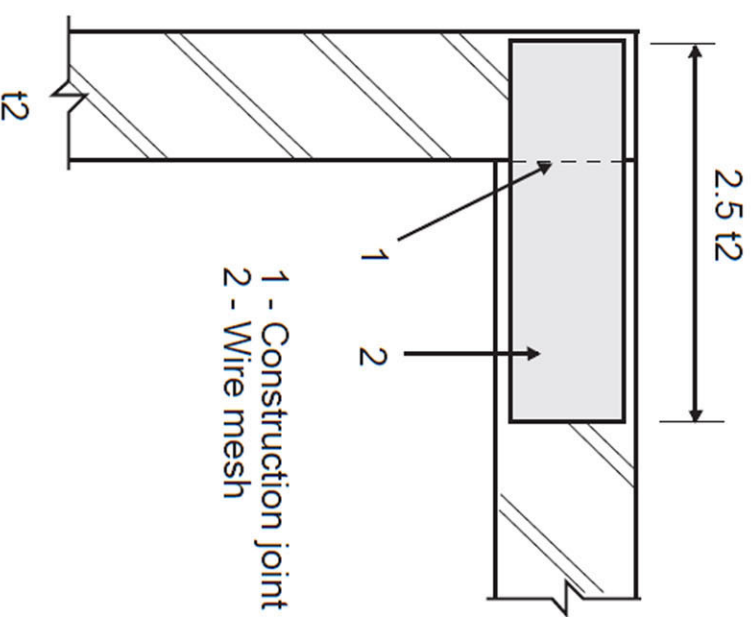
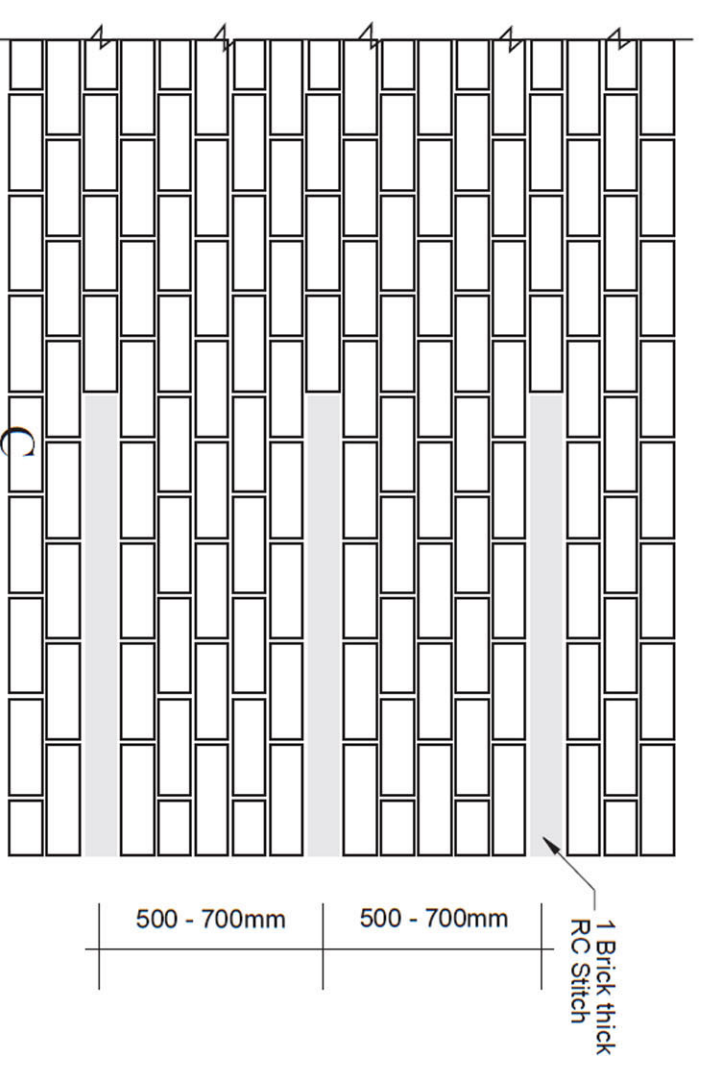
# Brick Masonry Boundary Wall Corner Strengthening Techniques



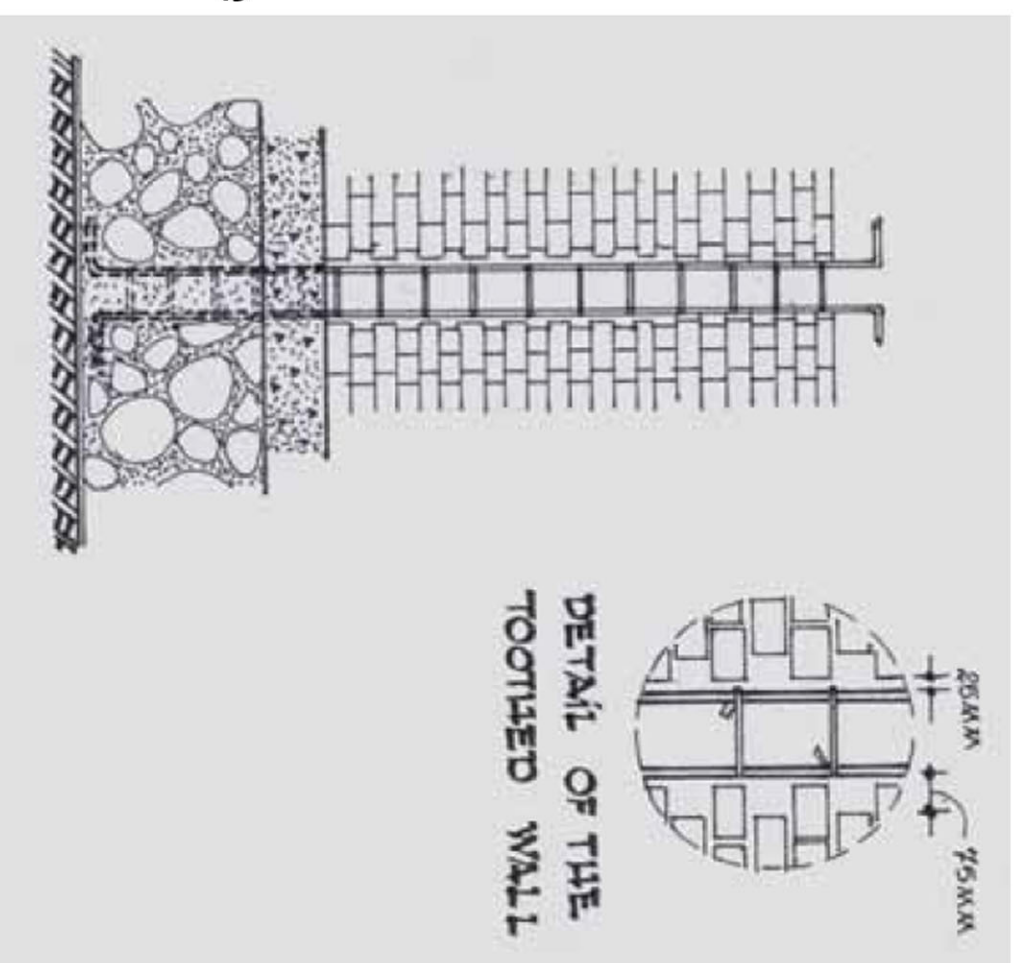
### Vertical reinforcement in corner junction for one full brick wall



### B Joint strengthening by dowel reinforcement placed in one joint

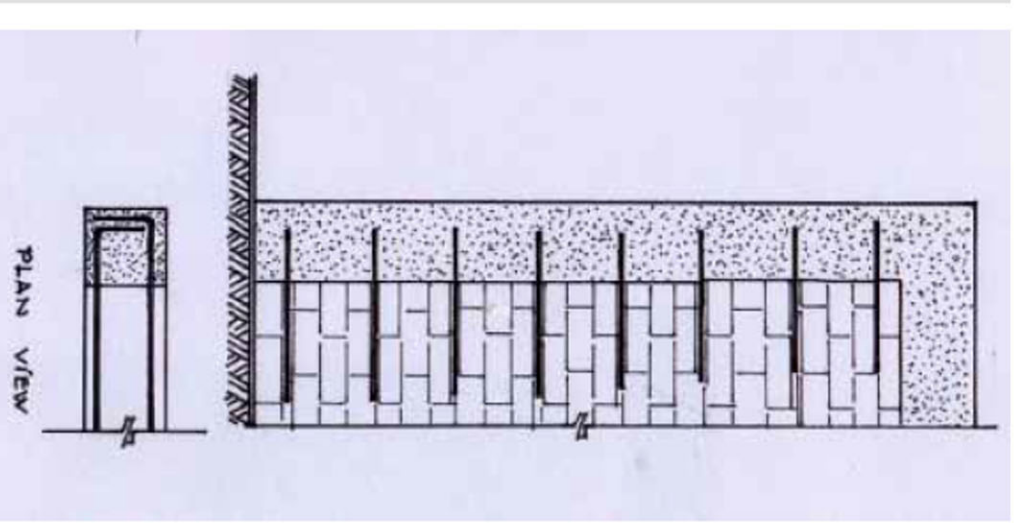


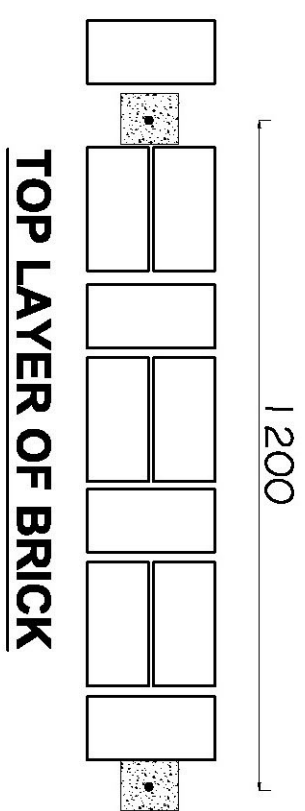
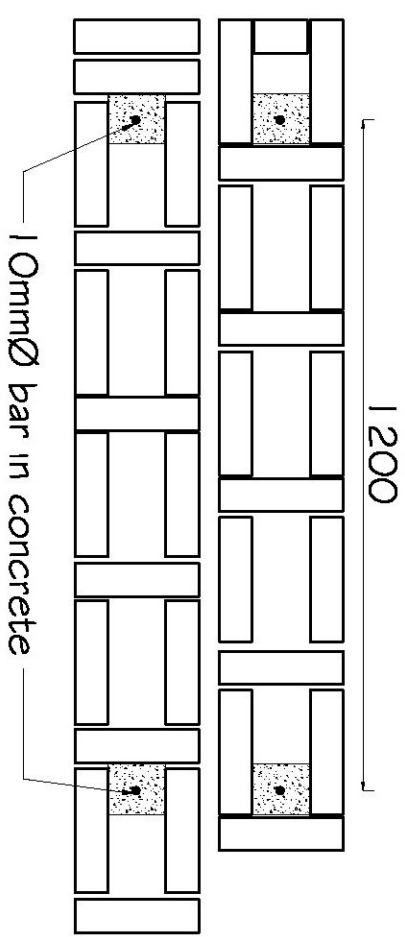
## Joint strengthening by mesh wire embedded into cement mortar



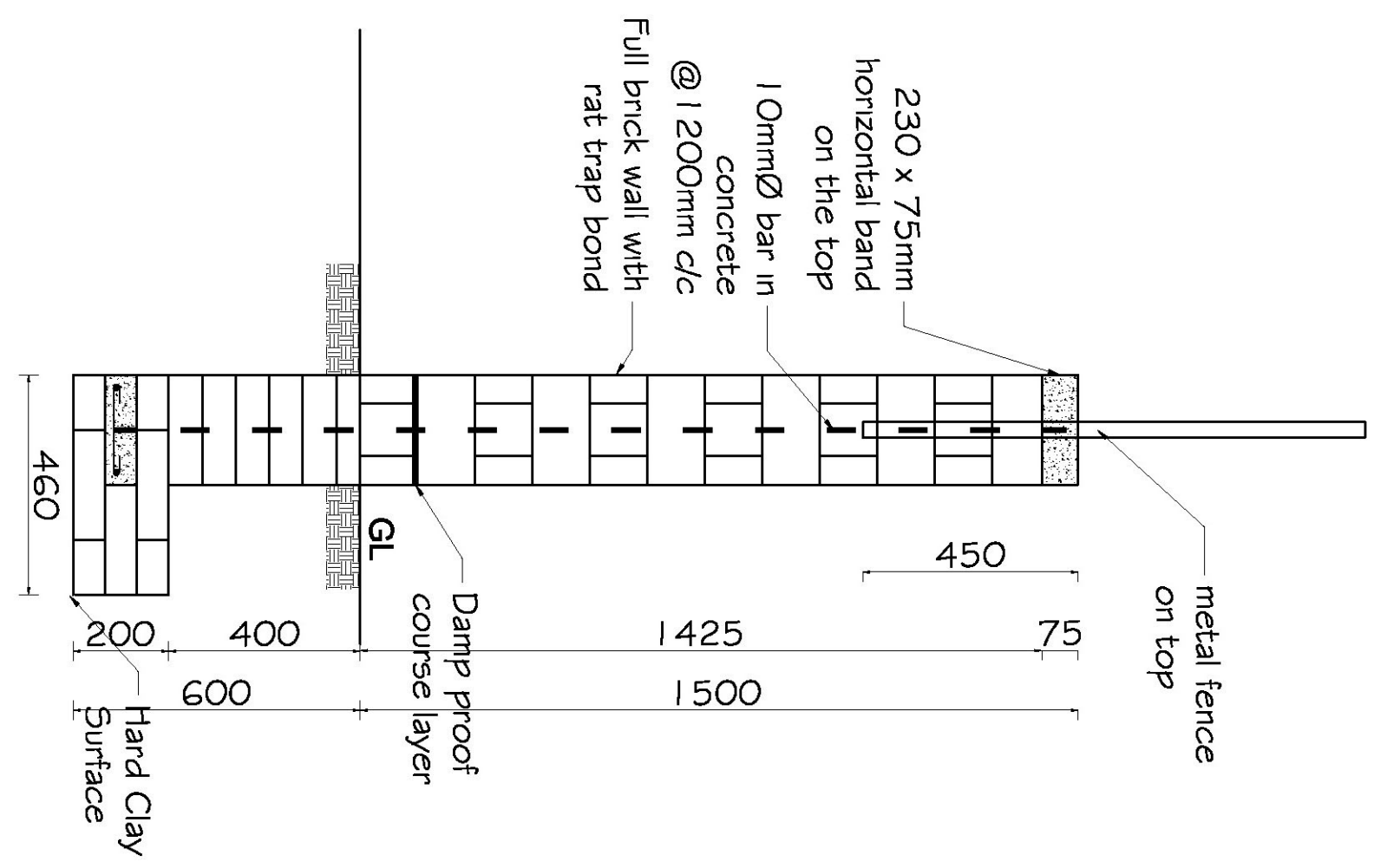
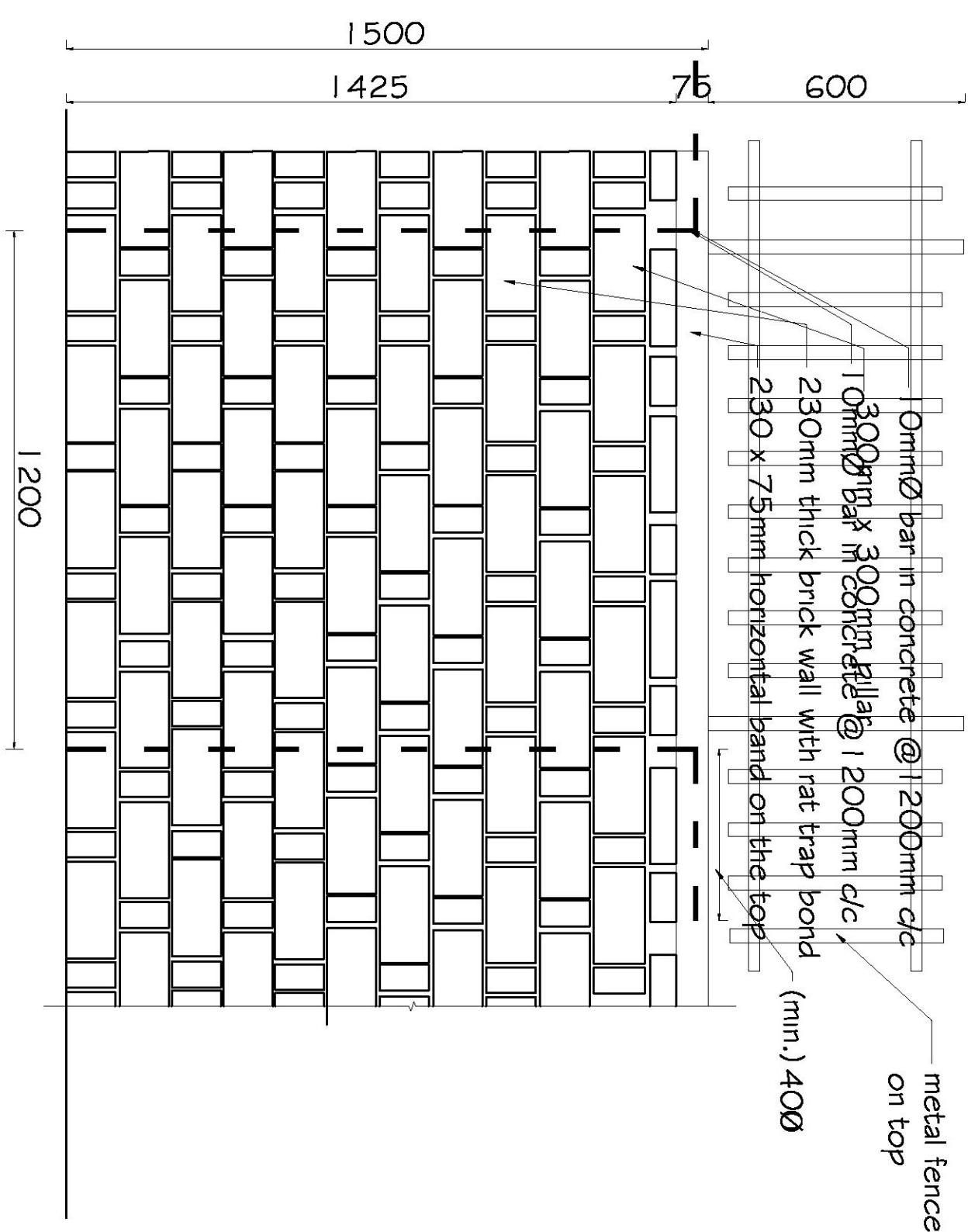
a) Toothed wall construction  
b) Horizontal dowels at wall-

# Joint strengthening between R.C. Pillar and Brick layer





**INTERMEDIATE LAYERS OF BRICK**

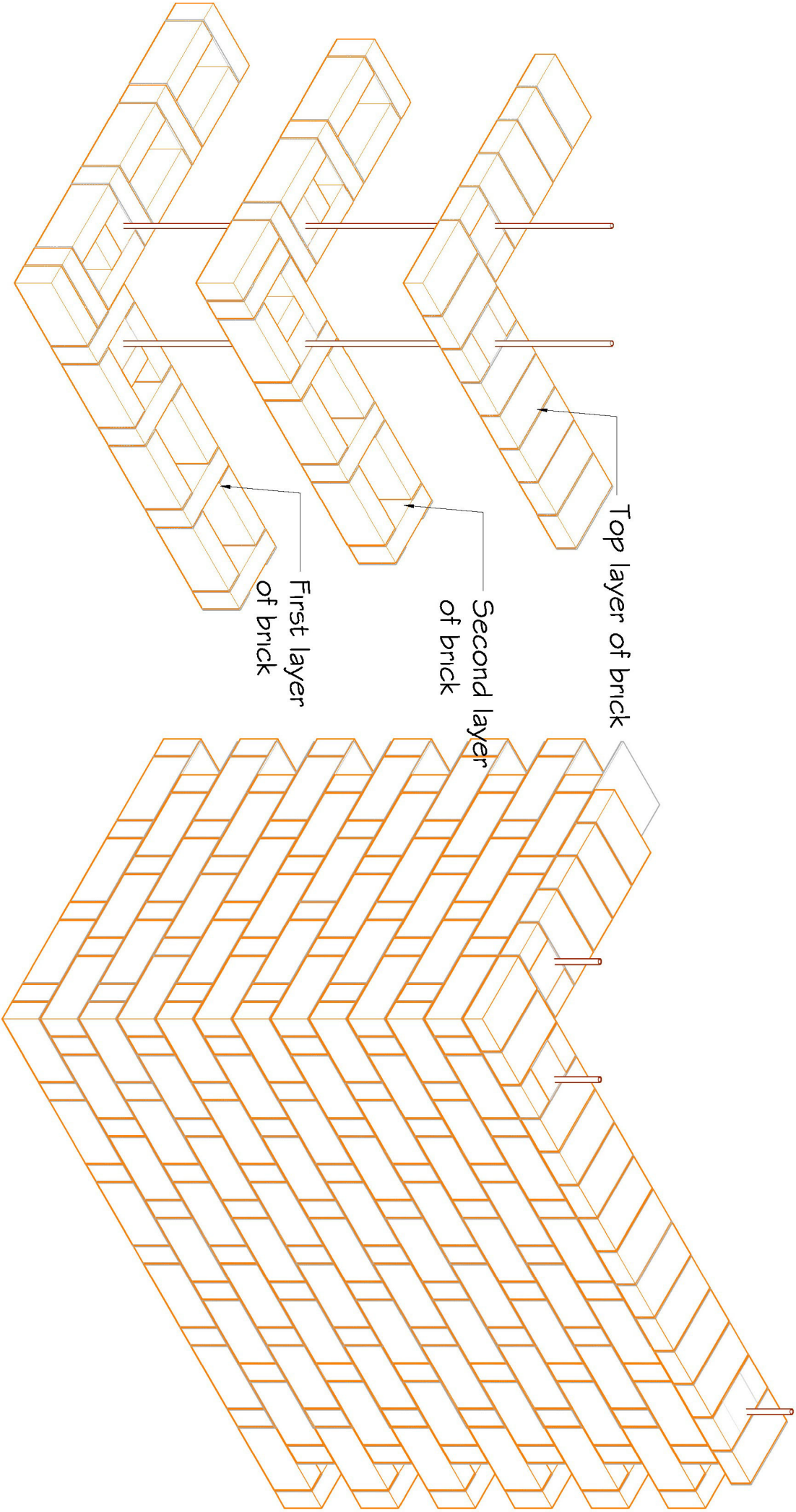


**ELEVATION SHOWING BOUNDARY WALL  
USING RAT TRAP BOND**

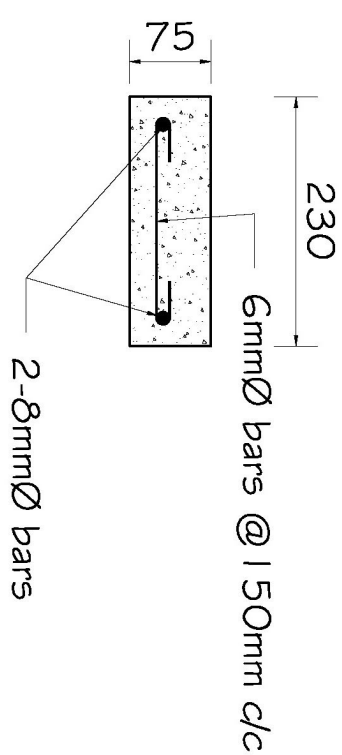
**Option-3: 230 mm thick wall with Rat Trap Bond**



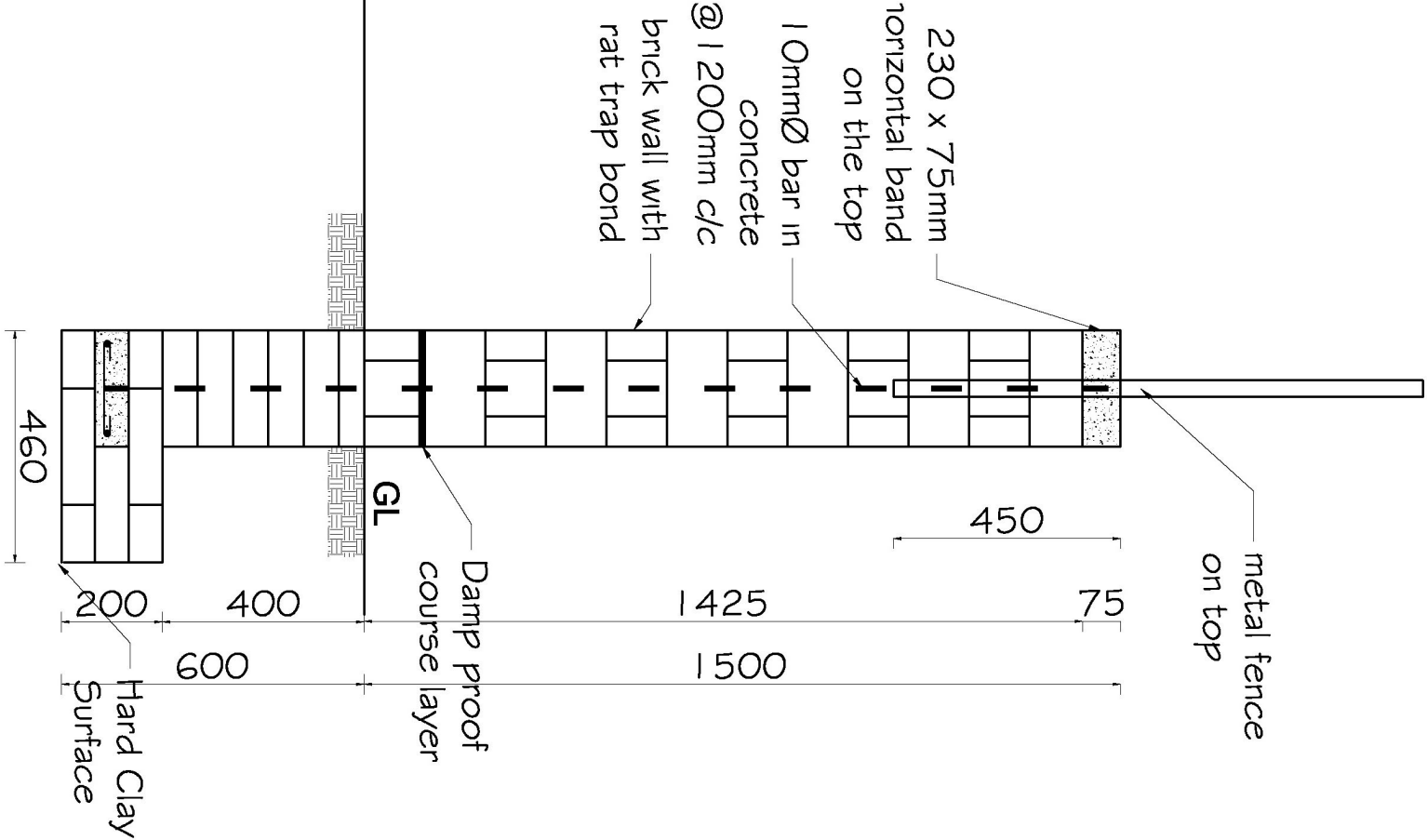
**Note:**  
Concrete grade: M15  
Cement mortar ratio : 1:3



3D VIEW SHOWING  
LAYERS OF WALL



3D VIEW OF WALL



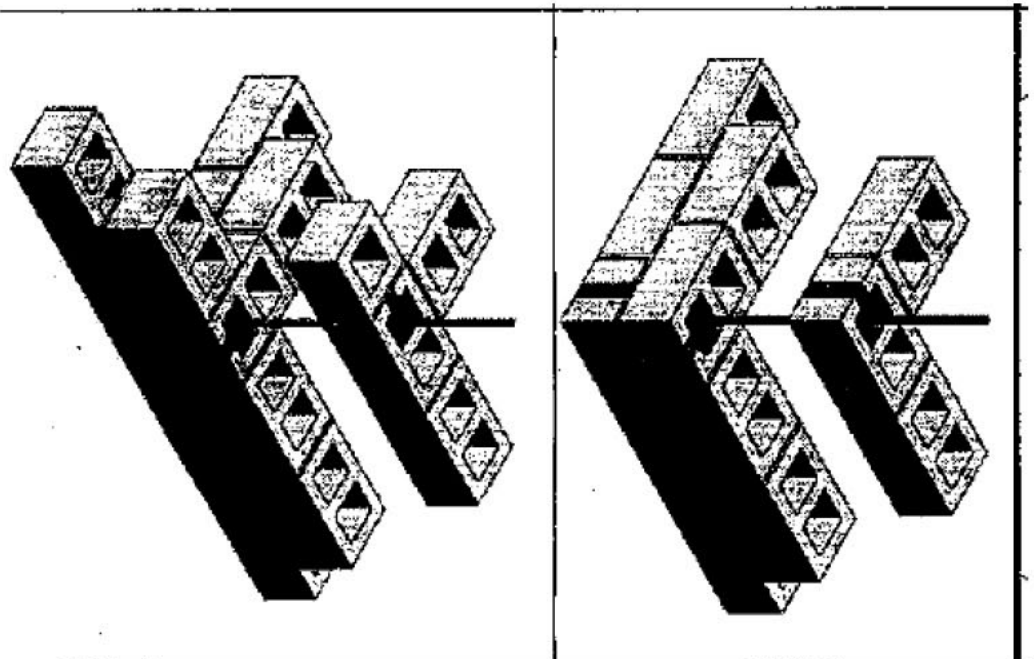
BOUNDARY WALL SECTION

**HORIZONTAL/FOUNDATION BAND**

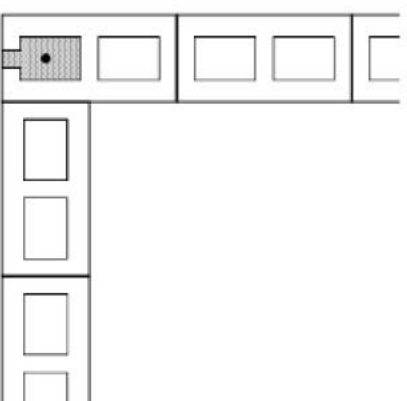
**Option-3: 230 mm thick wall with Rat Trap Bond**

## Hollow Concrete Block Masonry Boundary Wall

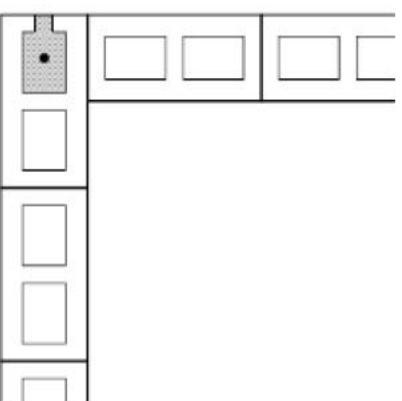
Corner reinforcement in case of  
Hollow Concrete Block Masonry



Blocks for Vertical bars

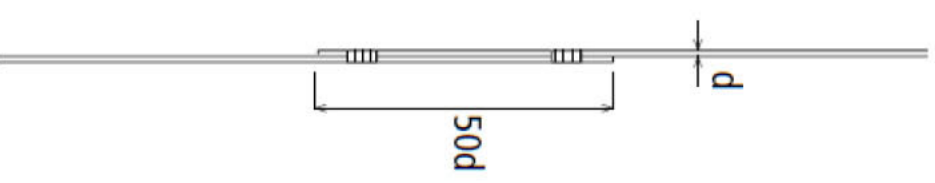


First layer



Second layer

Splicing of Vertical bars



**Note:** All construction techniques involved in Hollow Concrete Block Masonry Boundary Wall is similar to Brick Masonry Boundary Wall.

D) Random Rubble Stone Boundary Wall Construction (solid wall height < 4 feet):

Following construction method has been extracted from Bothara & Brzev 2011 publication.

- Masonry should be brought to course at every 600 millimeters (2 feet).
- Wall thickness should be between 380 millimeters to 450 millimeters.
- “Through stones” or “Bond stone: of full-length equal to wall thickness should be used in every 600 millimeters ( 2 feet) lift at not more than 1.2 meters (4 feet) apart horizontally. If full length stones are not available, stone in pairs, each of about  $\frac{3}{4}$  of the wall thickness may be used for one full length stone but an overlap between them should be as shown in figure.
- In place of “through stone”, bonding elements of steel bars of 8 to 10 millimeters diameter in S-shape or as a hooked link may be used with a cover of 25 millimeters from each face of the wall.
- Alternatively, wooden bars of 38 millimeters by 38 millimeters cross-section or a plain cement concrete block of 150 millimeters by 150 millimeters can also be used for the “through stone”.
- Long stones should be used at corners and junctions of walls to break the vertical joint and provide bonding between perpendicular walls as shown in drawing below.
- Alternatively vertical reinforcement can be used to strengthen the stone wall corners.
- Stitchings as shown in drawing below can be used for strengthening of wall corners.



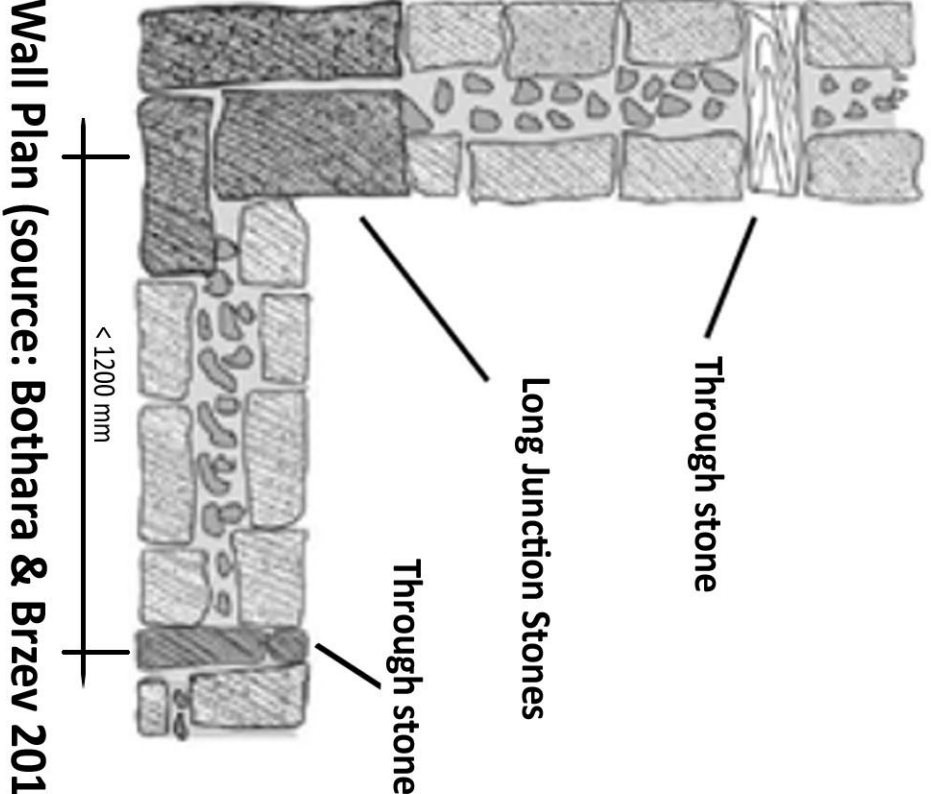
# Random Rubble Stone Masonry Boundary Wall

## Important Notes for Random Rubble Stone Masonry Boundary

### Wall Construction:

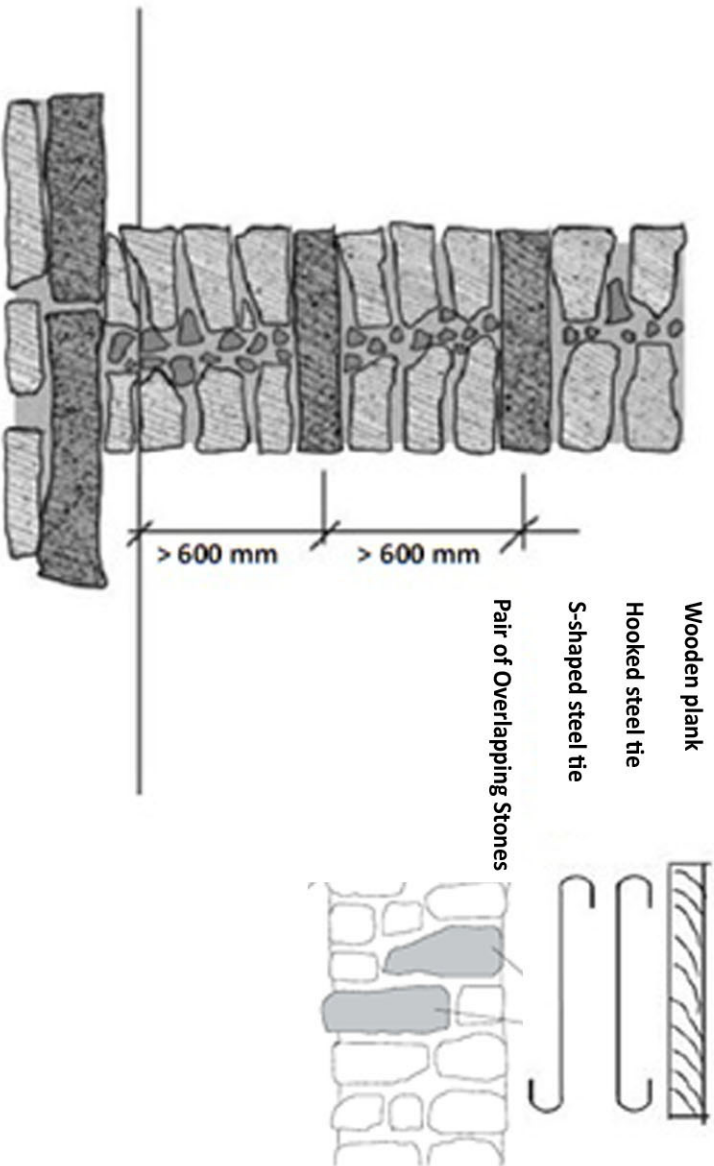
- 1) Masonry should be brought to course at every 600 mm (2 feet).
- 2) Wall thickness should be between 380mm to 450 mm.
- 3) “Through stones” or “Bond stones” of full-length equal to wall thickness should be used in every 600mm (2 feet) lift at not more than 1.2 m (4 feet) apart horizontally. If full length stones are not available, stones in pairs, each of about 3/4 of the wall thickness may be used for one full length stone but an overlap between them should be as shown in figure.
- 4) In place of “through stone”, bonding elements of steel bars of 8 to 10 mm diameter in S- shape or as a hooked link may be used with a cover of 25mm from each face of the wall.
- 5) Alternatively, wooden bars of 38mm x 38 mm cross-section or a plain cement concrete block of 150mm x 150 mm can also be used for the “through” stone.

(Source: Extracted from J. Bothara & et al. 2002)

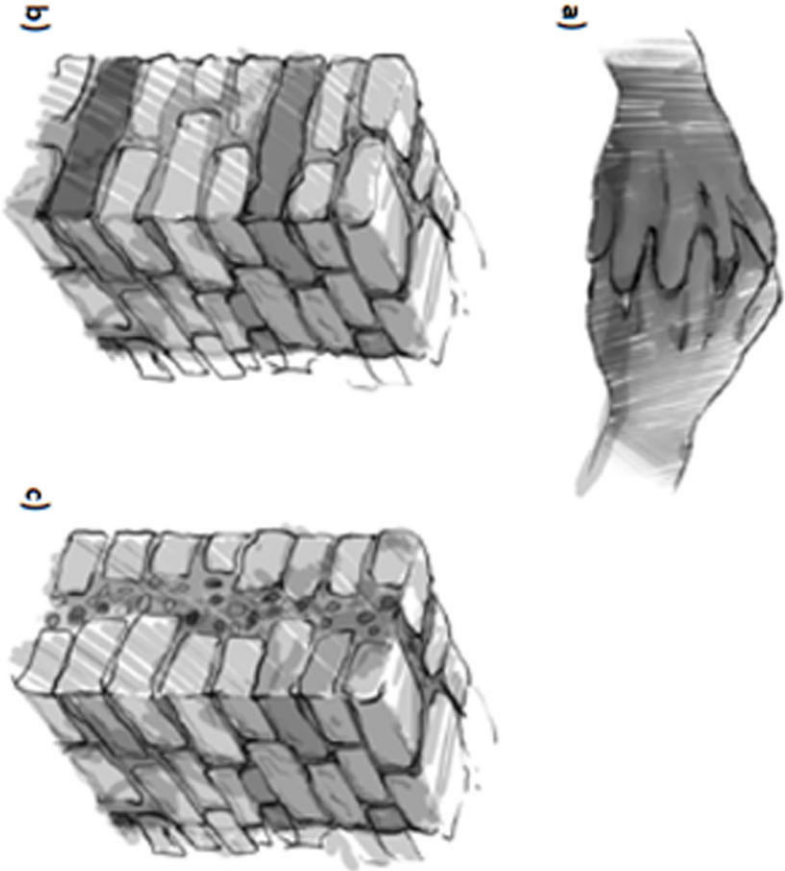


Wall Plan (source: Bothara & Brzev 2011)

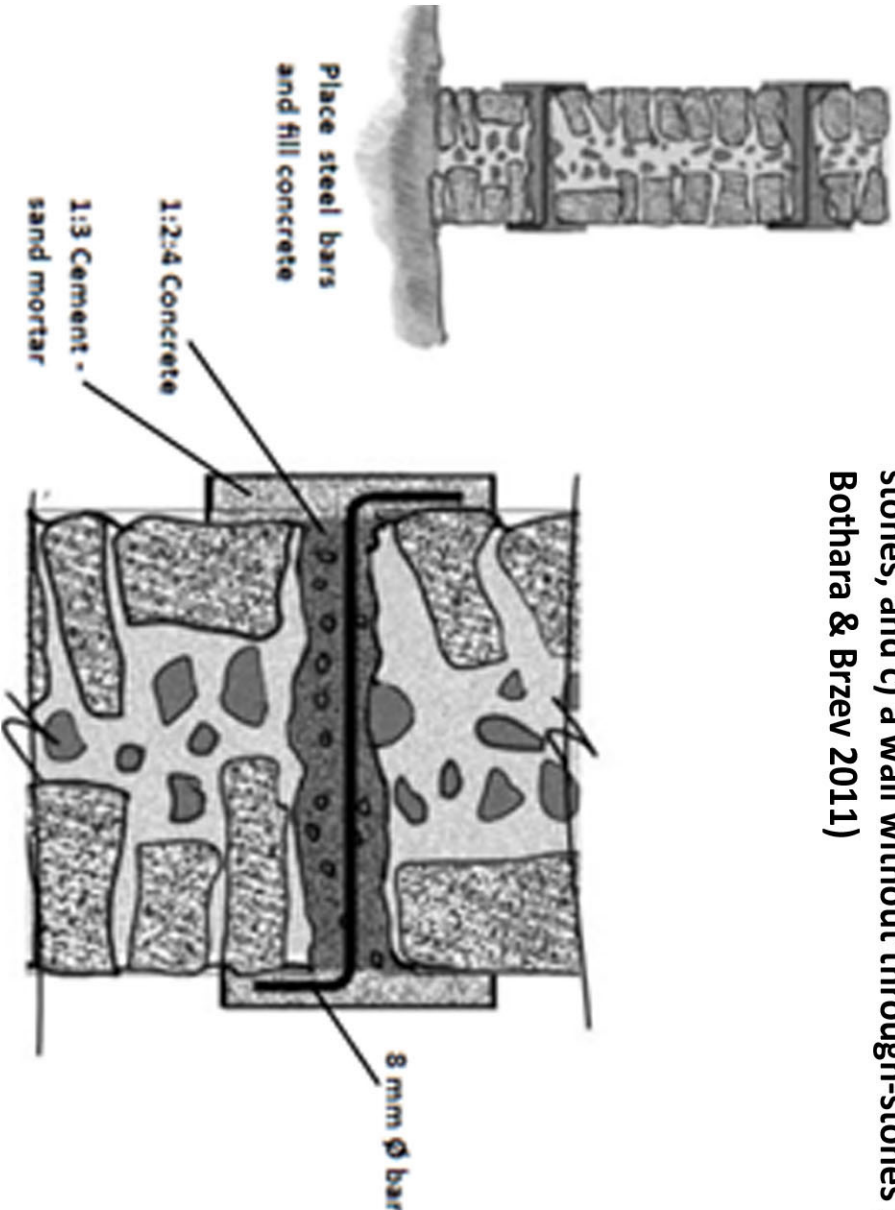
### Alternatives to Through-Stones



Wall Section (source: Bothara & Brzev 2011)



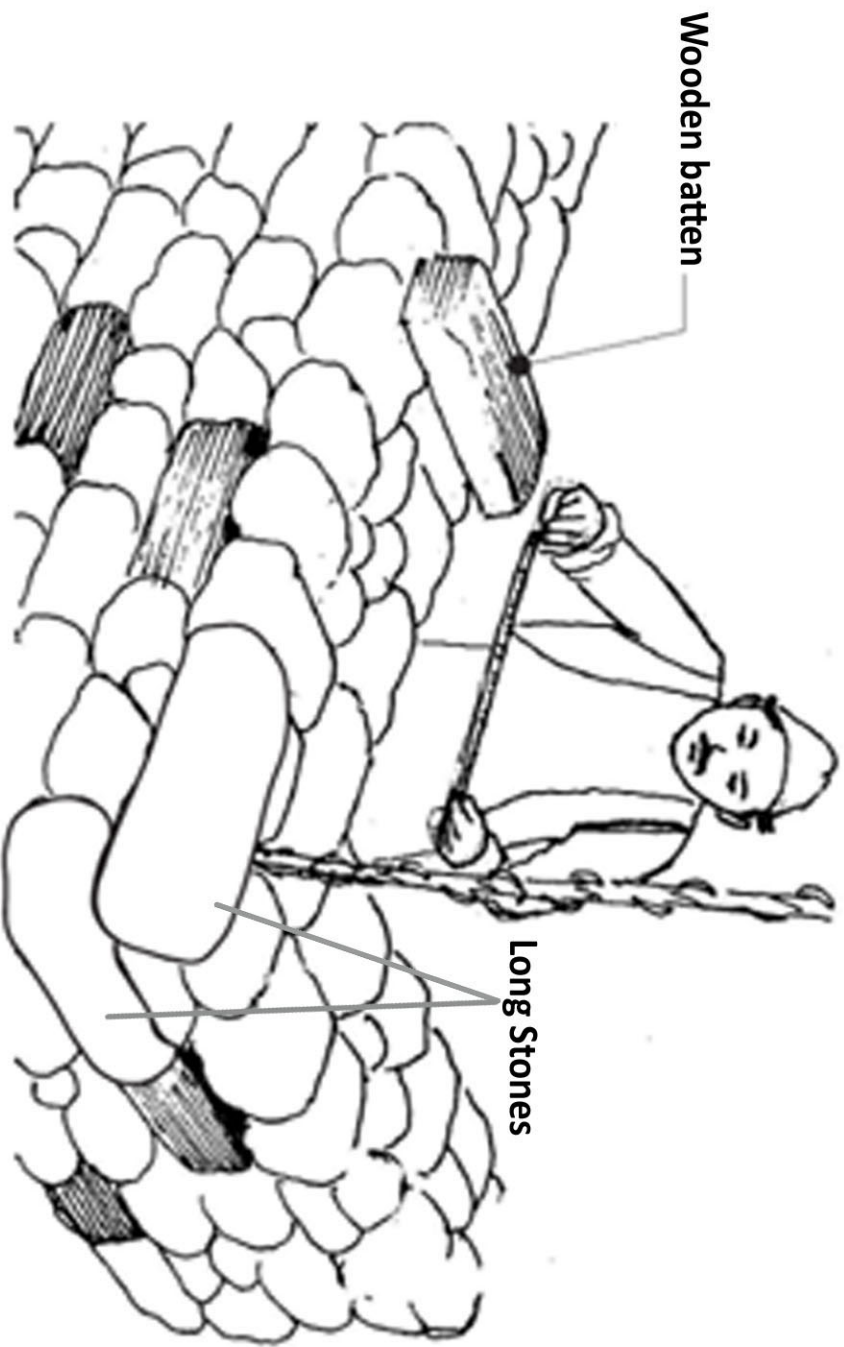
Through-stones in stone masonry walls: a) through-stones act like interlaced fingers; b) a wall with through-stones, and c) a wall without through-stones (source: Bothara & Brzev 2011)



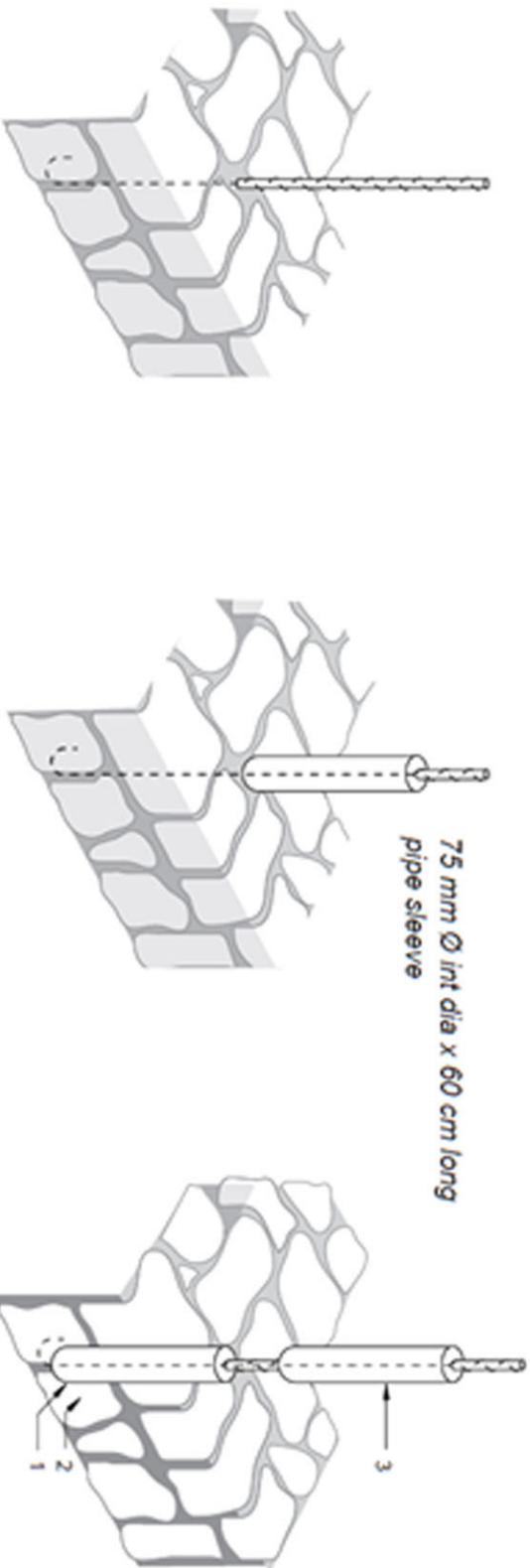
Use of S-shaped steel tie in place of “through stone” (source: Bothara & Brzev 2011)



# Random Rubble Stone Masonry Wall Corner Strengthening Techniques



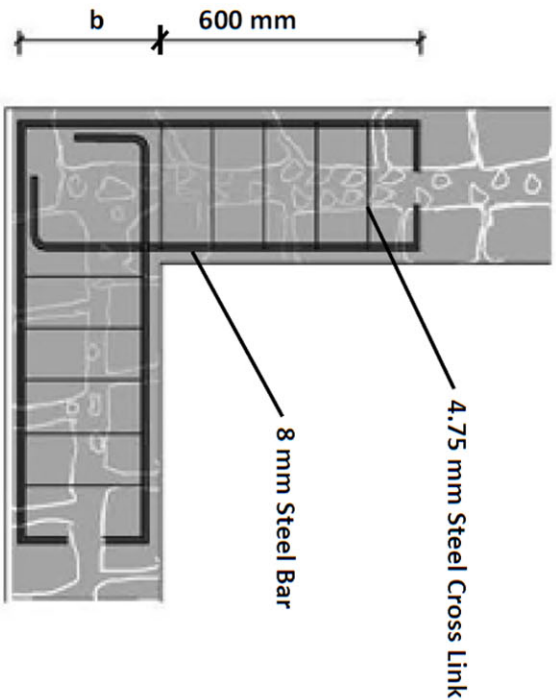
Corner Strengthening by using long stones



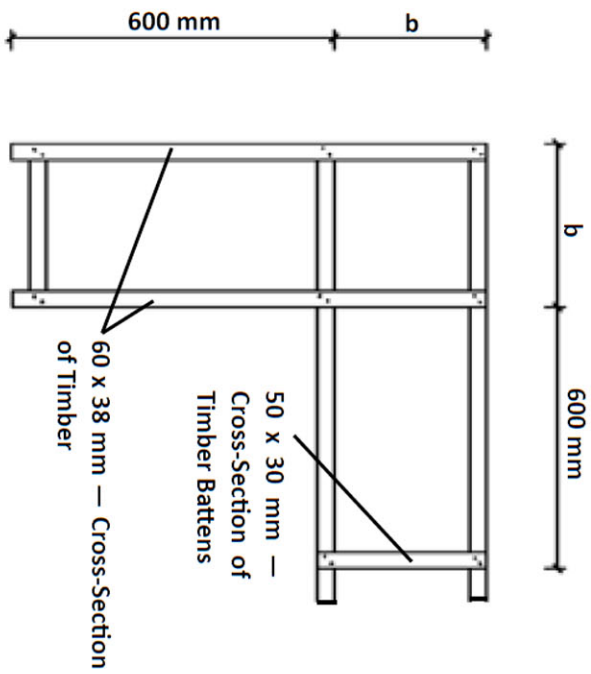
Corner Strengthening by using vertical reinforcement in rubble stone wall

- Use of pipe sleeve to create uniform void for reinforcement as per following steps:
1. Place pipe sleeve around reinforcement
  2. Build masonry around the pipe sleeve
  4. Fill the void with mixed concrete and coarse aggregate 10 mm
  5. Repeat process

Wall Corner Strengthening (Source: Bothara & et al. 2002)



a) Wall Stitches made from reinforced concrete with steel reinforcement

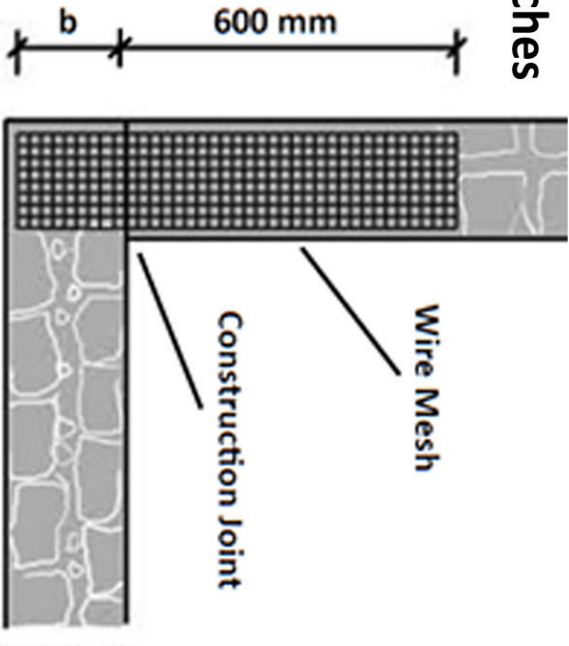


b) Wall Stitches made from Wood dowels at corners

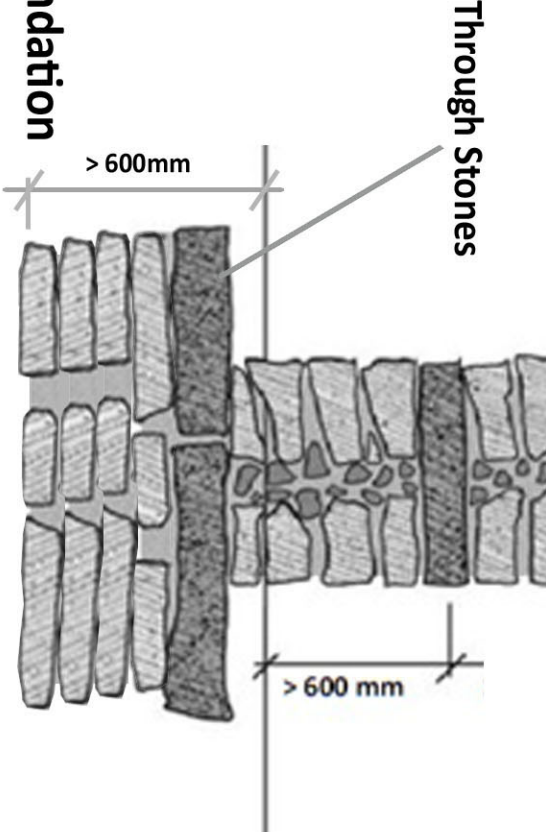
## Corner Strengthening by using Various Stitches (Source: Bothara & Brzev 2011)

### Important Notes:

- 1) Long Stones should be used at corners and junctions of walls to break the vertical joint and provide bonding between perpendicular walls as shown in figure.
  - 2) Alternatively vertical reinforcement can be used to strengthen the stone wall corners.
  - 3) Stitchings as shown in figures, can be used for strengthening of wall corners.
- (Source: Bothara & Brzev 2011)



c) Wall Stitches made from mesh wire embedded in mortar at corners



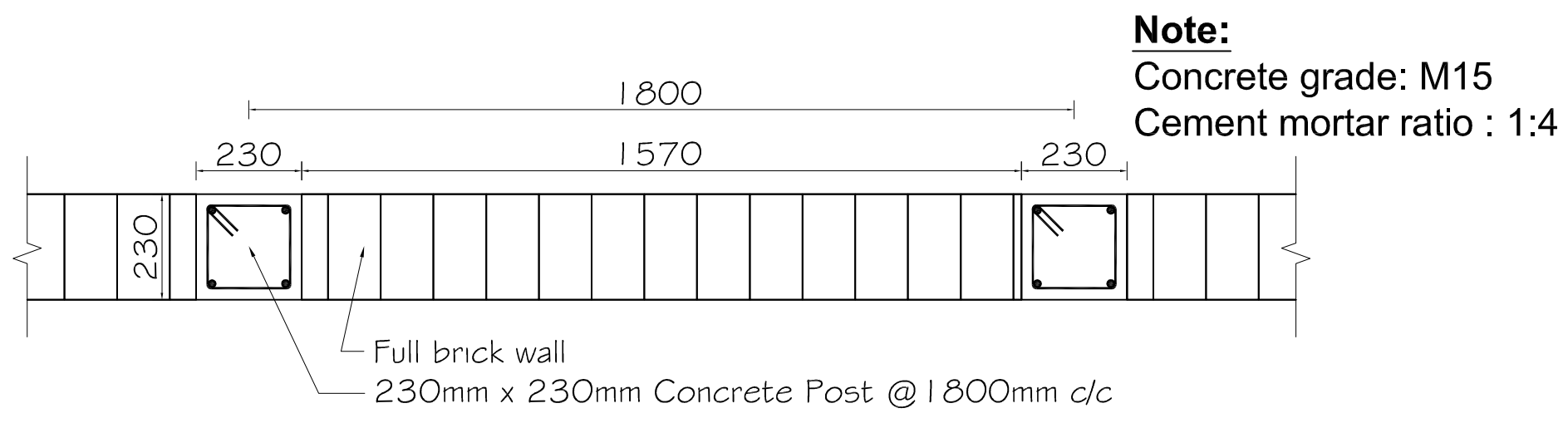
Wall Foundation

E) More than 5 feet & upto 8 feet high Solid one Full Brick Boundary Wall Construction:

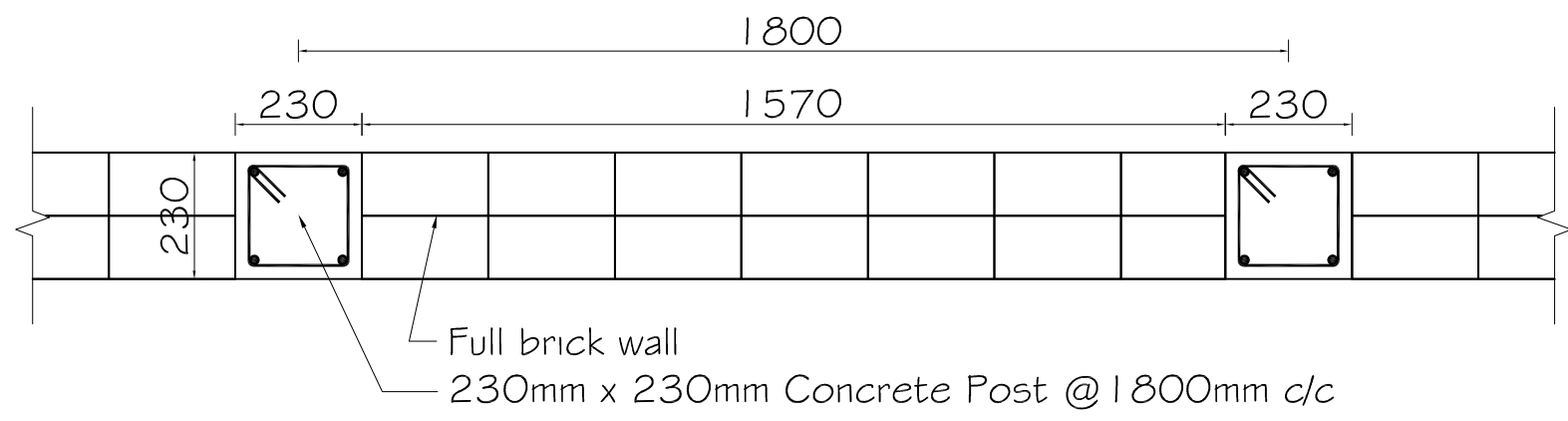
- Permission should be obtained from the concerned authorities before initiating wall design and full design approval should be gained from the authorities before construction. The authority will be responsible for proper inspection and monitoring during and after the completion of wall construction.
- The wall structure should be designed by structure engineer registered with Nepal Engineer's Council.
- Maximum height of wall could be upto 2.4 meters (8 feet) and includes 75 millimeters (3 inches) of R.C.C. band on top and at its mid portion measured from the ground floor level. These types of walls are recommended for high security sensitive purposes and should be approved by the local government. Each R.C.C. band consists of two numbers of 10 millimeters diameter reinforcement bars with stirrups of 8 millimeters diameter spaced at 150 millimeters (6 inches). The detail for post is shown in the drawing below.
- The wall should be strengthened by 230 mm X 230 mm (9 inches by 9 inches ) R.C.C. posts placed at the regular spacing of 1.8 meters (6 feet) center to center distance. Each R.C.C. post consists of 4 numbers of vertical reinforcement bar of 12 millimeters diameter tied with 8 millimeters diameter stirrups spaced at 150 millimeters (6 inches) distance.
- Concrete grade used should be M 15 and cement mortar ratio for masonry should be 1:4 sand mortar.
- Foundation should be at least 900 millimeters (3 feet) deep which must include R.C.C. footing of 9 inches or 225 millimeters deep and 600 millimeters (2 feet) wide. The footing should consist of 3 numbers of 10 millimeters diameter reinforcements tied with 8 millimeters diameter stirrups spaced at 150 millimeters (6 inches).
- View fencing of less than 600 millimeters (2 feet) could be installed on top of this solid brick masonry wall with its supporting posts directly aligned with the vertical reinforcement bars.
- It is recommended to plaster the top R.C.C. band with rain drip at its end.

F) More than 5 feet & upto 8 feet high Solid Shear Wall Construction:

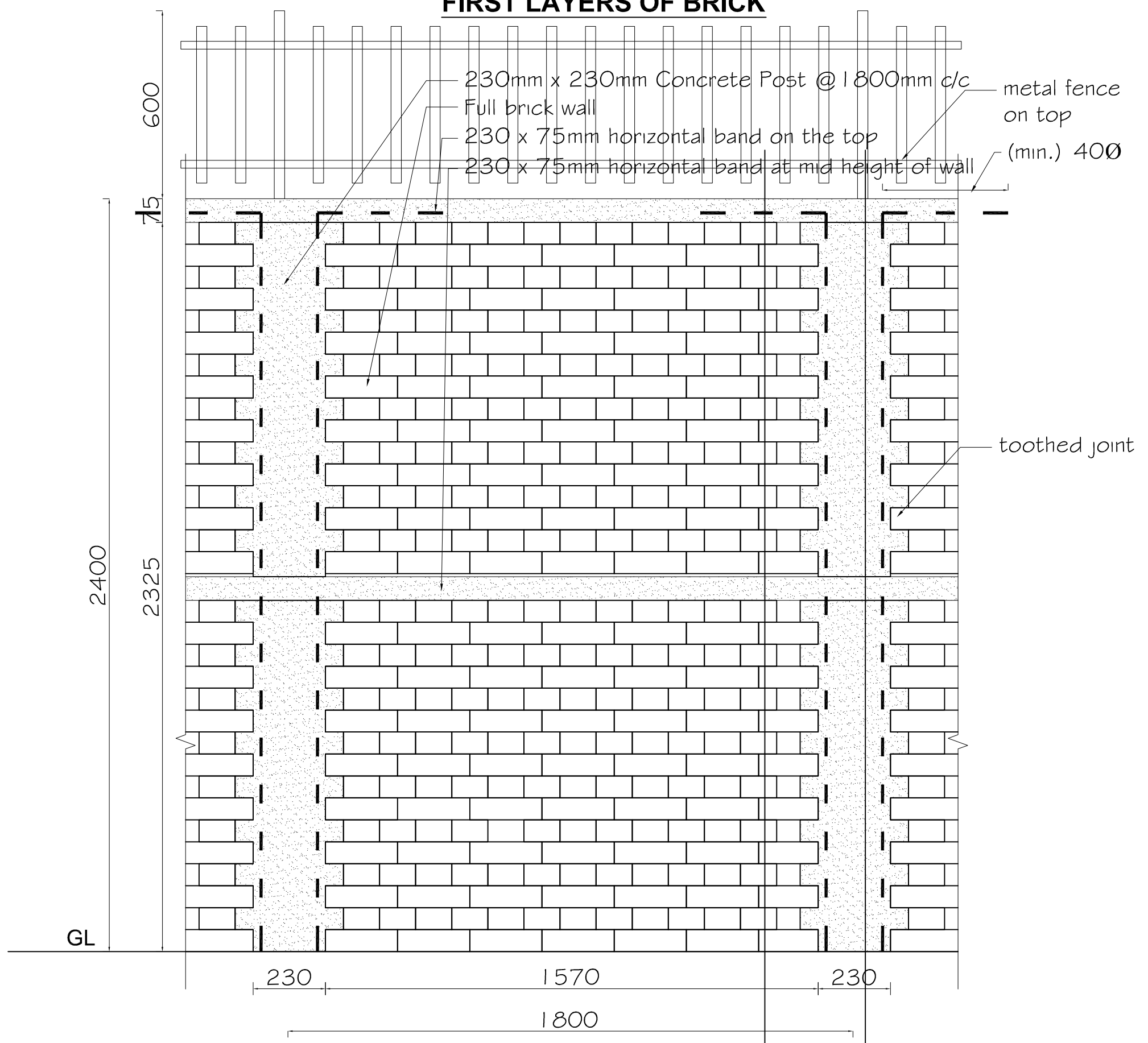
- Permission should be obtained from the concerned authorities before initiating wall design and full design approval should be gained from the authorities before construction. The authority will be responsible for proper inspection and monitoring during and after the completion of wall construction.
- The wall structure should be designed by structure engineer registered with Nepal Engineer's Council.



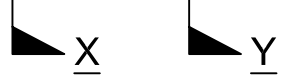
**SECOND LAYERS OF BRICK**



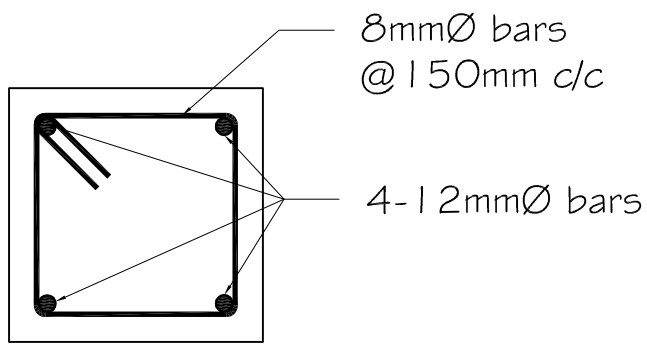
**FIRST LAYERS OF BRICK**



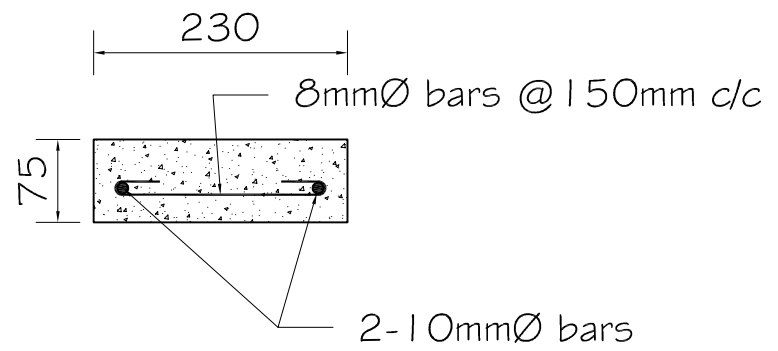
**High Wall (< 2.4 meters) BOUNDARY WALL**  
**(FULL BRICK THICK)**



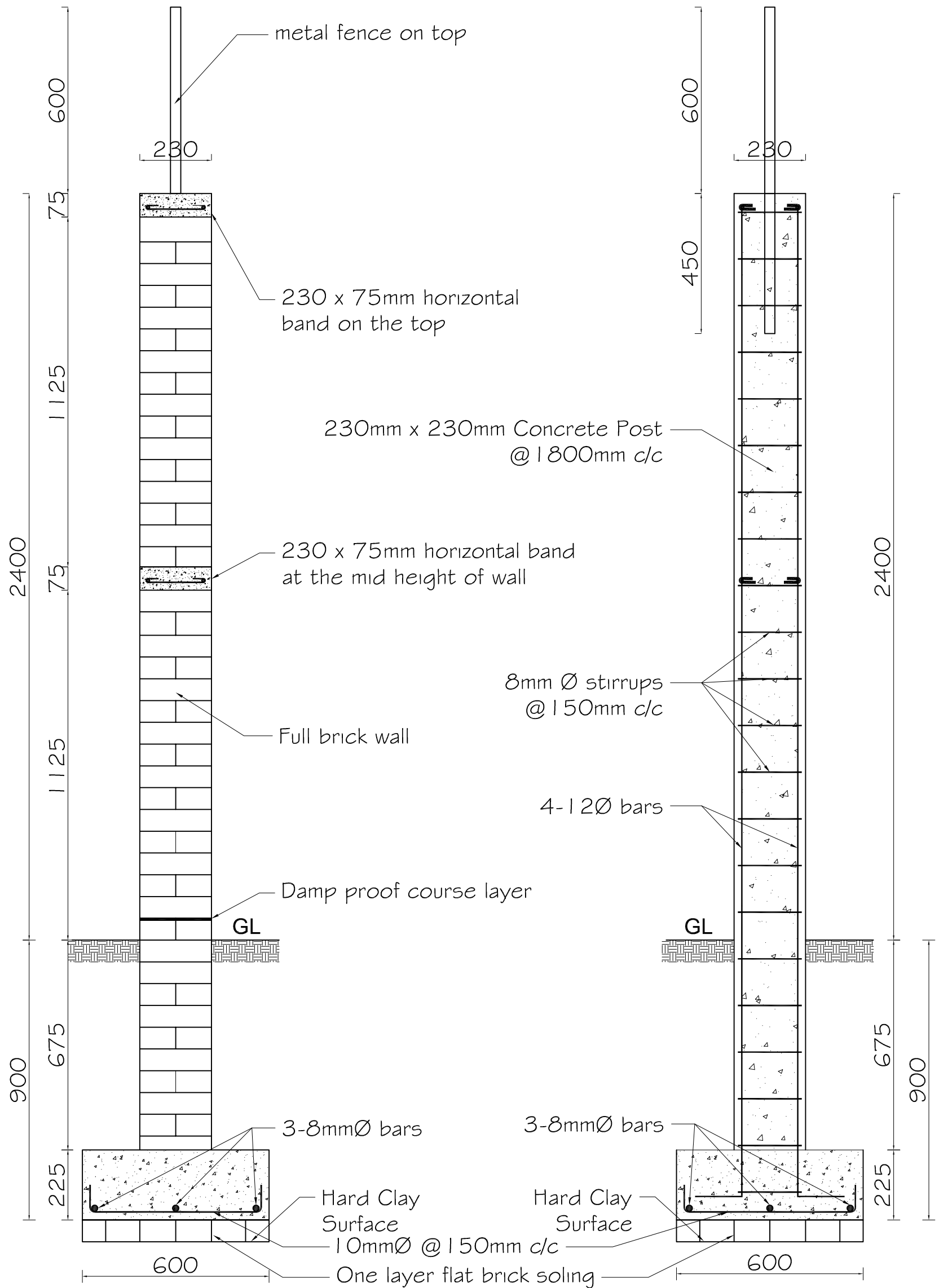




**COLUMN**



**HORIZONTAL BAND**



**WALL SECTION - X**

**WALL SECTION - Y**

## References:

Arya, A., Boen, T. & Ishiyama, Y. 2014. Guidelines for Earthquake Resistant Non-Engineered Construction, authors- Published by UNESCO.

Arya, A. & Panda, J. Earthquake Safe Construction of Masonry Buildings Zone V (details extracted from IS: 4326-1993 Code of Practice), prepared under the GOI- UNDP Disaster Risk Management Division.

Brzev, S. 2007. Earthquake-Resistant Confined Masonry Construction, prepared for National Information Center of Earthquake Engineering Indian Institute of Technology Kanpur India.

Bothara, J. & Brzev, S., 2011. A Tutorial: Improving the Seismic Performance of Stone Masonry Buildings, published by Earthquake Engineering Research Institute, Oakland, California.

Bothara, J., Guragain, R. & Dixit, A., 2002. Protection of Educational buildings against earthquakes: A Manual for Designers and Builders, published by NSET-Nepal, supported by NSET-Nepal, OFDA/USAID & UNESCO-Kathmandu.