

Assignment 1

Student Name: Richard Murray

Student ID Number: 0851739

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Contents

Table of Figures	3
Structural Scheming	4
Ground Floor – Column and Foundation View	5
Ground Floor Layout (U/S First Floor Layout) – Proposed Beams and Load Transfers	6
Structural Loading Schedule	7
Roof	8
First Floor	9
Slab	9
Beam Loading	10
Durability Design	12
Analysis of Critical Slab – Reinforced Concrete	16
Section 1 - Slab Design	18
Section 2 – Moment Calculation	19
Section 3 – Steel Reinforcement	20
Analysis and Design of Two Span Continuous Beam	21
Beam Analysis	22
Distribution Factor	22
Fixed End Moment	22
Balance Moments	22
Support Reaction Calculations	23
Shear Moment and Bending Moment Calculation	25
Beam Design	27
Section 1	28
Section 2	29
Section 3	30
Analysis and Design of Column	32
Design of Reinforced Concrete Pad Footing for above Column	33
Bibliography	35
Reference List	36

Table of Figures

Figure 1 - Slab design process (Bond et al., n.d.. pp.19)	17
Figure 2 - Cross sectional area per metre for Bar Spacing - Reinforced Concrete Slab	20
Figure 3 - Beam Design Process (Bond et al., n.d.) pp.27	27
Figure 4 - Cross Sectional Area of Groups of Bars for Beam Design	30

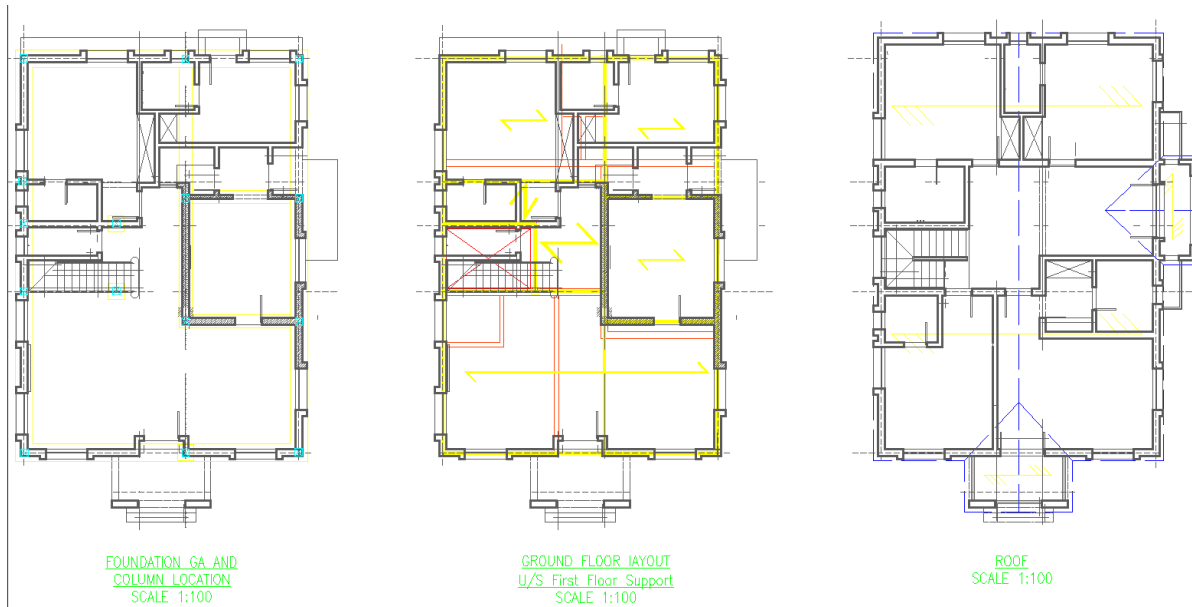
Appendix List

- Appendix I – Architectural Drawings – ACBA 6007_CW_Drawings.pdf
- Appendix II – Structural Overview
- Appendix III – Column and Foundation Overview
- Appendix IV – Ground Floor U/S Layout

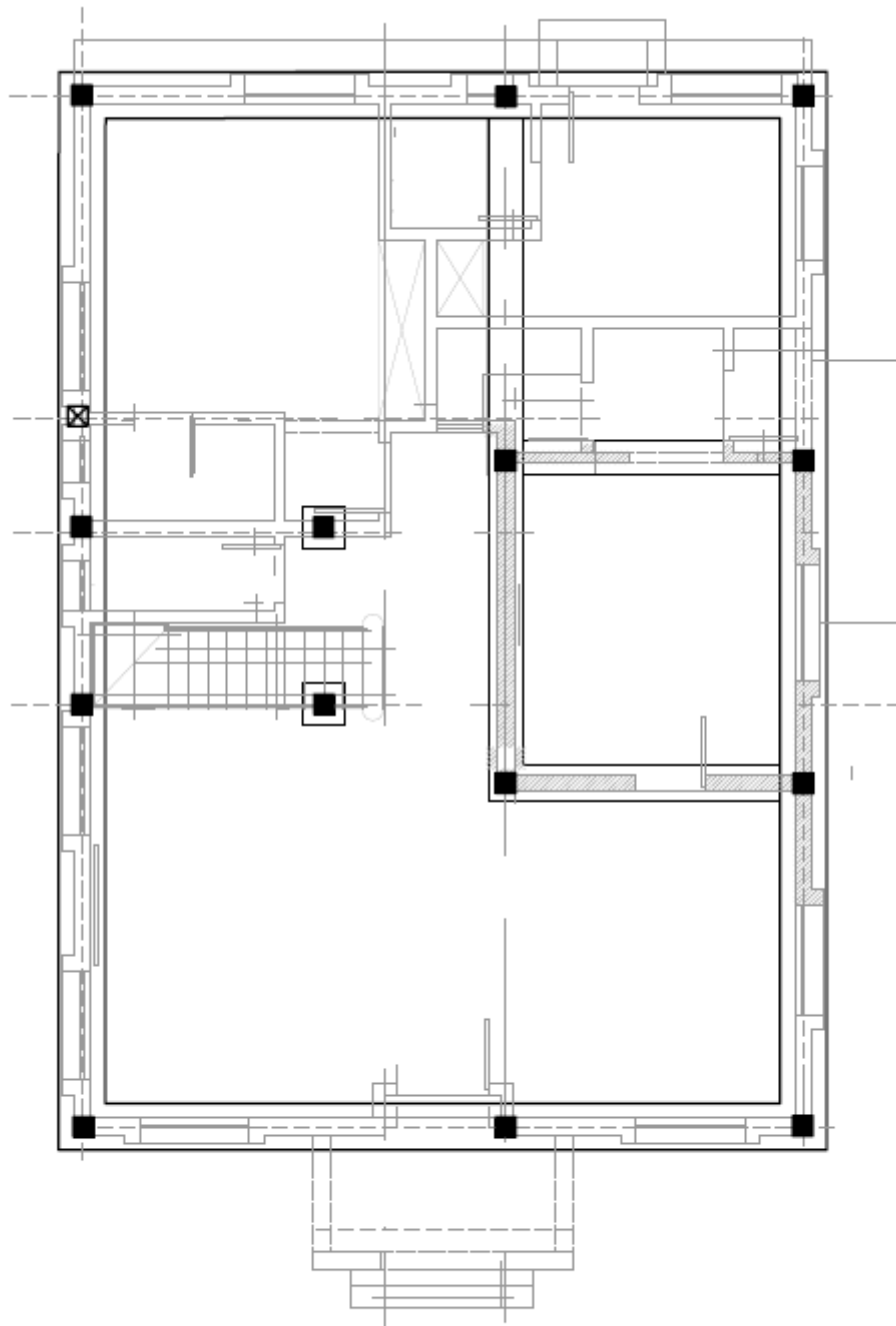
Structural Scheming

Please see below for the proposed structural framing for the plan shown in Appendix A – Architectural

Plan for proposed Residential Property

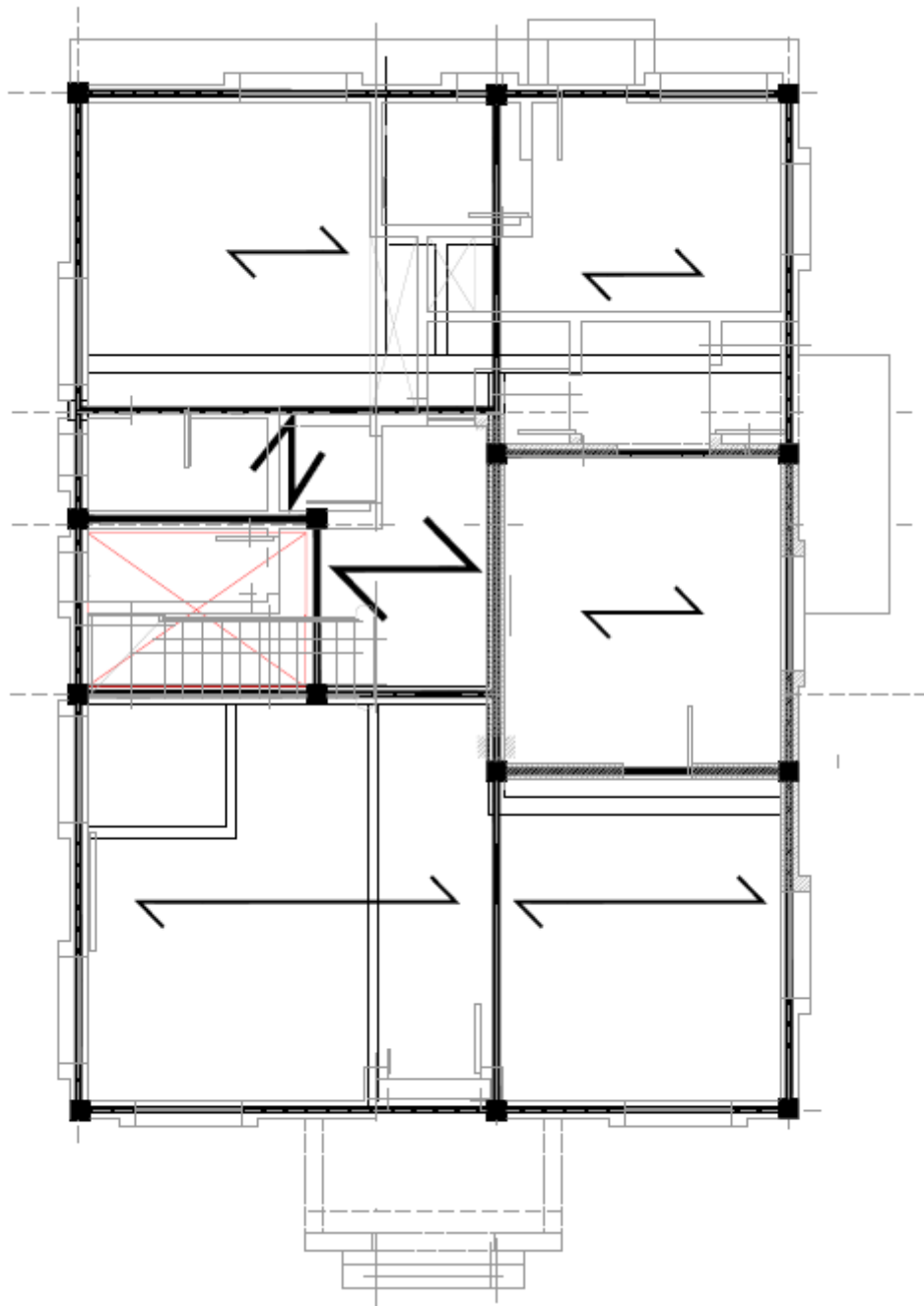


Ground Floor – Column and Foundation View



FOUNDATION GA AND
COLUMN LOCATION

Ground Floor Layout (U/S First Floor Layout) – Proposed Beams and Load Transfers



Structural Loading Schedule

Residential Building shown in Architectural plans (See Appendix I) is classified as a single family dwelling. Due to this utilising the table 6.2 from (British Standards Institution (2010). Pp22) as shown below;

Categories of loaded areas	q_k [kN/m ²]	Q_k [kN]
Category A		
- Floors	1,5 to <u>2,0</u>	<u>2,0</u> to 3,0
- Stairs	<u>2,0</u> to 4,0	<u>2,0</u> to 4,0
- Balconies	<u>2,5</u> to 4,0	<u>2,0</u> to 3,0
Category B	2,0 to <u>3,0</u>	1,5 to <u>4,5</u>
Category C		
- C1	2,0 to <u>3,0</u>	3,0 to <u>4,0</u>
- C2	3,0 to <u>4,0</u>	2,5 to 7,0 (<u>4,0</u>)
- C3	3,0 to <u>5,0</u>	<u>4,0</u> to 7,0
- C4	4,5 to <u>5,0</u>	3,5 to <u>7,0</u>
- C5	<u>5,0</u> to 7,5	3,5 to <u>4,5</u>
category D		
- D1	<u>4,0</u> to 5,0	3,5 to 7,0 (<u>4,0</u>)
- D2	4,0 to <u>5,0</u>	3,5 to <u>7,0</u>

Building would fall under Category A. However when utilising UK Natatiol Annex to Eurocode 1: Actions on Structures Part 1-1, this is further explained by table NA.2 (British Standards Institution (2002) pp.8) as shown below;

Category of loaded area	Specific use	Sub-category	Example
A	Areas for domestic and residential activities	A1	All usages within self-contained dwelling units (a unit occupied by a single family or a modular student accommodation unit with a secure door and comprising not more than six single bedrooms and an internal corridor) Communal areas (including kitchens) in blocks of flats with limited use (see Note 1). For communal areas in other blocks of flats, see A5, A6 and C3
		A2	Bedrooms and dormitories except those in self-contained single family dwelling units and in hotels and motels
		A3	Bedrooms in hotels and motels; hospital wards; toilet areas
		A4	Billiard/snooker rooms
		A5	Balconies in single family dwelling units and communal areas in blocks of flats with limited use (see Note 1)
		A6	Balconies in hostels, guest houses, residential clubs and communal areas in blocks of flats except those covered by Note 1
		A7	Balconies in hotels and motels

As determined above, the outlined building shown in Architectural plan (Appendix I) is a Single Family Dwelling, it falls under section 'A-A1 – All usages with self-contained dwelling units (a unit occupied by a single family'. As such all Live Load calculations will reflect the above.

In order to ensure that adequate loading is calculated the roof will also be included within the expected dead load, the expected loading will be calculated from (Cobb, 2014).

Roof

From supplied Architectural drawing (Appendix 1) the below will be assumed;

- Timber pitched roof with manufactured Trusses
- Trusses will be lifted into space by crane
- Area has normal attic space with no intention to utilise area for habitation

As such expected loads would be expected and sourced from (Cobb, 2014. pp.97)

Dead Load (gk)

- Slates, Timber battens and Felt – 0.55KN/m^2
- Timber Rafters and Insulation – 0.2KN/m^2
- Ceiling and Services 0.2KN/m^2

Total Dead Load – 1.0KN/m^2

Live Load (qk)

Snow Loading – 0.6KN/m^2

Ultimate Load

$$1.4g_k + 1.6q_k = (1.4 \times 1) + (1.6 \times 0.6) = (1.4) + (0.96) = 2.36\text{KN/m}^2$$

First Floor

Slab

First floor encompassed bedrooms and toilet facilities along with corridor access. From the above explanation this space will fall under A1. This area will be subject to the following assumptions;

- Stairs within building are free standing structure, as such do not impart any loads on structural members or structural floor slab.
- Assumption of simply supported 2 way Reinforced Concrete slabs with thickness of 150mm (as shown in Architectural Plan (See Appendix I))

Dead Load (gk) – Concrete density taken from (Cobb, 2014. pp.89)

- Self Weight of concrete slab

$$SW = 24 * 0.15 = 3.6KN/m^2$$

- Partition Loading – $1KN/m^2$
- Screed (15mm Thick)

$$SW = 22 * 0.015 = 0.33KN/m^2$$

- Ceiling and Services – $0.25KnN/m^2$

From the above the total expected Dead Load (gk) from First Floor is expected to be;

$$gk = 3.6 + 1 + 0.33 + 0.25 = 5.18KN/m^2$$

Live (qk)

From the above indication and outlined in UK Natatiol Annex to Eurocode 1: Actions on Structures

Part 1-1, this structure would all under A1, as such Live loads would be as below;

Category of loaded area		q_k kN/m ²	Q_k kN
Category A	A1	1,5	2,0
	A2	1,5	2,0
	A3	2,0	2,0
	A4	2,0	2,7
	A5	2,5	2,0
	A6	Same as the rooms to which they give access but with a minimum of 3,0	2,0 (concentrated at the outer edge)
	A7	Same as the rooms to which they give access but with a minimum of 4,0	2,0 (concentrated at the outer edge)

As such the live loads as shown by q_k are 1.5KN/m²

From the above the Ultimate Limit Load would be classified by the below equation;

Ultimate Limit Load

$$1.4gk + 1.6qk = (1.4 * 5.18) + (1.6 * 1.5) = 7.252 + 2.4 = 9.652KN/m^2$$

Beam Loading

Each beam installed within the structural framing is assumed to be made from Reinforced Concrete

(See Beam Analysis Section). As such it is important to take note of their expected self weight. As this is self-weight it is attributed as a permeant load (i.e. Dead Load)

Assumption Reinforced concrete beams with face area of 450mm*225mm

$$0.45 * 0.225 = 0.102m^2$$

Dead load –SW

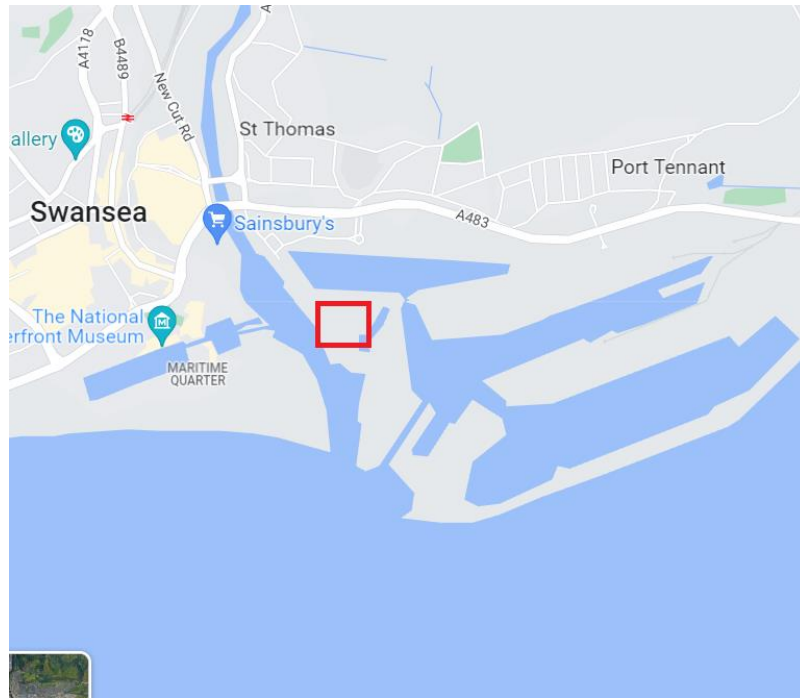
$$SW \text{ of Beam} = 24 * 0.102 = 2.448 = 2.45KN/m^2$$

Ultimate Beam Load (Addition of Factor of Safety)

$$(1.4 * 2.45) = 3.43KN/m^2$$

Durability Design

Proposed residential dwelling is proposed to be located beside IQ Building in Swansea near Kings Road. See proposed layout below;



(Image Taken from Google Earth)

Reference Manual	Description	Output
	Floor Slab	
	Bar Size - Assumed Bar Size 12mm - Assumed Cover shall be greater than recommended bar size >12mm	
British Standards Institution. (2014) NA+AS:2014 to BS EN 1992-1-1:2004+A1:2014– Section 4.4.1.2 Table 4.2	Aggregate Size - If nominal size of aggregate is >32mm, C_{min} should be increased by 5.	

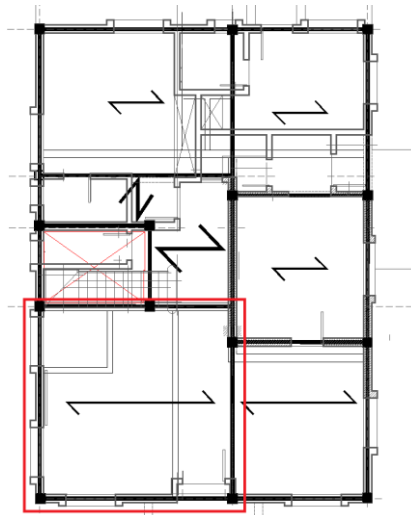
	- Assumed Aggregate size shall be 20mm - $C_{min} > 20\text{mm}$	
British Standards Institution. (2014) NA+AS:2014 to BS EN 1992-1-1:2004+A1:2014. <i>UK National Annex to Eurocode 2</i>, Table 4.1 p.51, and Table 4.4 p.53	Exposure Condition - Environment is considered to be located within urban area. However is near the sea. - Proposed Concrete is within structural building with low humidity. - Table 4.1 is XC1. - Concrete Grade C30/37 - Nominal Cover $> 10\text{mm}$	
	Fire Resistance - 1 hr fire resistance is assumed. $C_{min} > 20\text{mm}$ - Additional 5mm Cover to be installed to increase fire protection.	
	Minimal Cover for Floor Slab = 25mm	C=25mm
	Beams	
	Bar Size - Assumed Bar Size 16mm - Assumed Cover shall be greater than recommended bar size $> 12\text{mm}$	
British Standards Institution. (2014) NA+AS:2014 to BS EN 1992-1-1:2004+A1:2014. <i>UK National Annex to Eurocode 2</i>– Section 4.4.1.2 Table 4.2	Aggregate Size - If nominal size of aggregate is $> 32\text{mm}$, C_{min} should be increased by 5.	

	- Assumed Aggregate size shall be 20mm - Cmin >20mm	
British Standards Institution. (2014) NA+AS:2014 to BS EN 1992-1-1:2004+A1:2014. <i>UK National Annex to Eurocode 2</i>, Table 4.1 p.51, and Table 4.4 p.53	Exposure Condition - Environment is considered to be located within urban area. However is near the sea. - Proposed Concrete is within structural building with low humidity. - Table 4.1 is XC1. - Concrete Grade C30/37 - Nominal Cover >10mm	
British Standards Institution (2008) Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design. British Standards Institution.	Fire Resistance - 1 hr fire resistance is assumed. Cmin >20mm - Assumed Cover equal to Slab	
	Minimal Cover for Beams= 20mm	C=20mm
	Columns	
	Bar Size - Assumed Bar Size 16mm - Assumed Cover shall be greater than recommended bar size >12mm	
British Standards Institution. (2014) NA+AS:2014 to BS EN 1992-1-1:2004+A1:2014. <i>UK National Annex to Eurocode 2: Design of Concrete Structures – Part 1-1: General rules and rules for buildings – Section 4.4.1.2 Table 4.2</i>	Aggregate Size - If nominal size of aggregate is >32mm, Cmin should be increased by 5. - Assumed Aggregate size shall be 20mm - Cmin >20mm	

British Standards Institution. (2014) NA+AS:2014 to BS EN 1992-1-1:2004+A1:2014. <i>UK National Annex to Eurocode 2: Design of Concrete Structures – Part 1-1: General rules and rules for buildings</i> ,Table 4.1 p.51, and Table 4.4 p.53	Exposure Condition - Environment is considered to be located within urban area. However is near the sea. - Proposed Concrete is within structural building with low humidity. - Table 4.1 is XC1. - Concrete Grade C30/37 - Nominal Cover >10mm	
British Standards Institution (2008) Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design. British Standards Institution.	Fire Resistance - 1 hr fire resistance is assumed. Cmin >20mm - Assumed Cover equal to Slab	
	Minimal Cover for Columns= 20mm	C=20mm

Analysis of Critical Slab – Reinforced Concrete

From the structural scheme drawing (See Appendix II), the nominated critical slab is shown below within the red square;



This slab has been identified as being the critical slab as the area is below both a bed room and toilet facilities, as such it will be subject to the same loads as the other slabs within the structure. It is also has the largest single span from column to column. This is important as a slab designed for a larger space can be utilised in a smaller enclosure without suffering structural failure, however the reverse will result in structural failure.

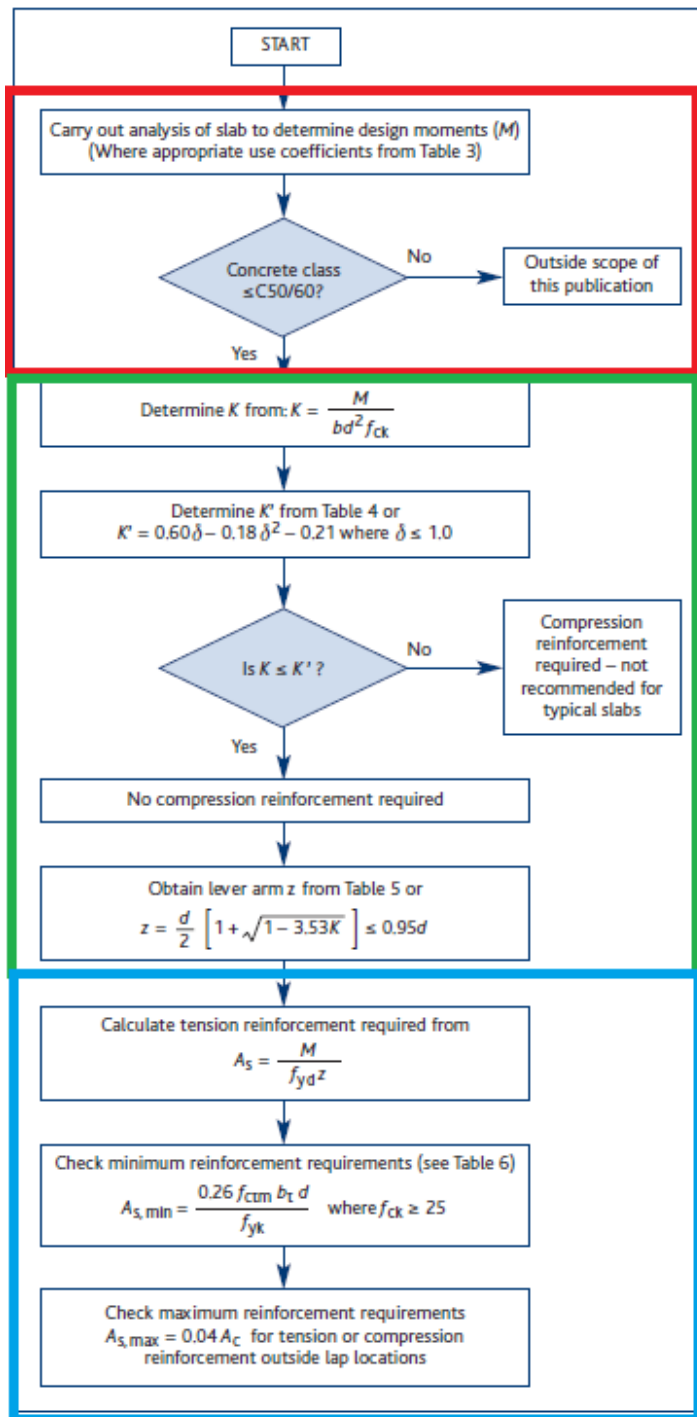


Figure 1 - Slab design process (Bond et al., n.d.. pp.19)

Figure 1 (Bond et al., n.d.. pp.19)

shows the process of designing the slab as identified above. The process will be divided into 3 sections'

- Section 1 – (Highlighted Red)

Analysis of the slab

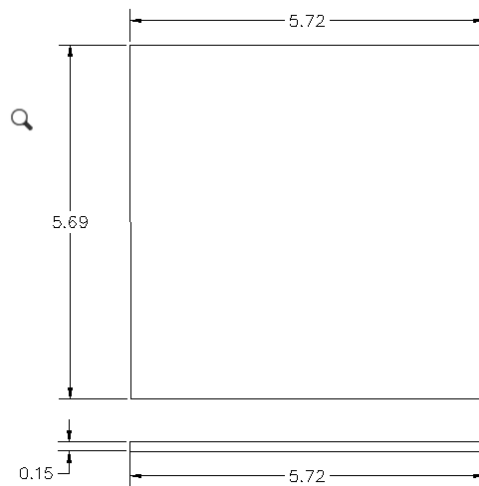
- Section 2 – (Highlighted Green) –

Calculation of K Prime, and Moments acting on proposed slab

- Section 3 – (Highlighted Blue) –

Calculation of Reinforcement required (min and max)

Section 1 - Slab Design



Dead Load

$$\text{Slab } gk + \text{Roof } gk = 5.18 + 1 = 6.18 \text{KN/m}^2$$

Live Load

$$\text{Slab } qk + \text{Roof } qk = 1.5 + 0.6 = 2.1 \text{KN/m}^2$$

Ultimate Limit Load

$$1.4gk + 1.6qk = (1.4 * 6.18) + (1.6 * 2.1) = (8.652) + (3.36) = 12..012 \text{KN/m}^2$$

Section 2 – Moment Calculation

Design Moment (M)

$$M = \frac{wL^2}{8} = \frac{12.012 * 5.72^2}{8} = \frac{12.012 * 5.72^2}{8} = \frac{393.013}{8} = 49.127 \text{KN/m}^2$$

Fck = (Concrete Grade C30/37=30)

Design Life = 100 Years

Exposure Condition = XC1

Cover (c) = 25mm

h=total height of slab = 150mm

$$d = h - \left(\frac{\phi_{bar}}{2}\right) - c = 150 - \left(\frac{12}{2}\right) - 25 = 119 \text{mm}$$

Equation above M is in KN/m², this needs to be converted into Nmm, this is achieved by multiplying M E 6.

$$M = 49.127 * 10^6 = 49127000$$

$$K = \frac{M}{F_c u b d^2} = \frac{491270000}{25 * 1000 * 119^2} = \frac{49127000}{354025000} = 0.139 = 0.139$$

$$K_{prime} = 0.156$$

$$K = < 0.156$$

Finding Z

$$Z = \frac{d}{2} (1 + \sqrt{1 - 3.53k}) \leq 0.95d = Z = \frac{119}{2} (1 + \sqrt{1 - 3.53 * 0.139}) = 101.96$$

$$101.96 \leq 0.95d = 0.95 * 119 = 113.05$$

Z is less than the amount indicated, as such it will be used to calculate the required steel.

Section 3 – Steel Reinforcement

$$A_s = \frac{M}{F_{yd} * Z} = \frac{491270000}{500 * 101.96} = \frac{48268000}{500 * 101.96} = 935.34 \text{ mm}^2$$

Utilising Table 3.22 as shown below, the recommended reinforcement is to;

Table 3.22 Cross-sectional area per metre width for various bar spacing (mm²)

Bar size (mm)	Spacing of bars								
	50	75	100	125	150	175	200	250	300
6	566	377	283	226	189	162	142	113	94.3
8	1010	671	503	402	335	287	252	201	168
10	1570	1050	785	628	523	449	393	314	262
12	2260	1510	1130	905	754	646	566	452	377
16	4020	2680	2010	1610	1340	1150	1010	804	670
20	6280	4190	3140	2510	2090	1800	1570	1260	1050
25	9820	6550	4910	3930	3270	2810	2450	1960	1640
32	16100	10700	8040	6430	5360	4600	4020	3220	2680
40	25100	16800	12600	10100	8380	7180	6280	5030	4190

Figure 2 - Cross sectional area per metre for Bar Spacing - Reinforced Concrete Slab

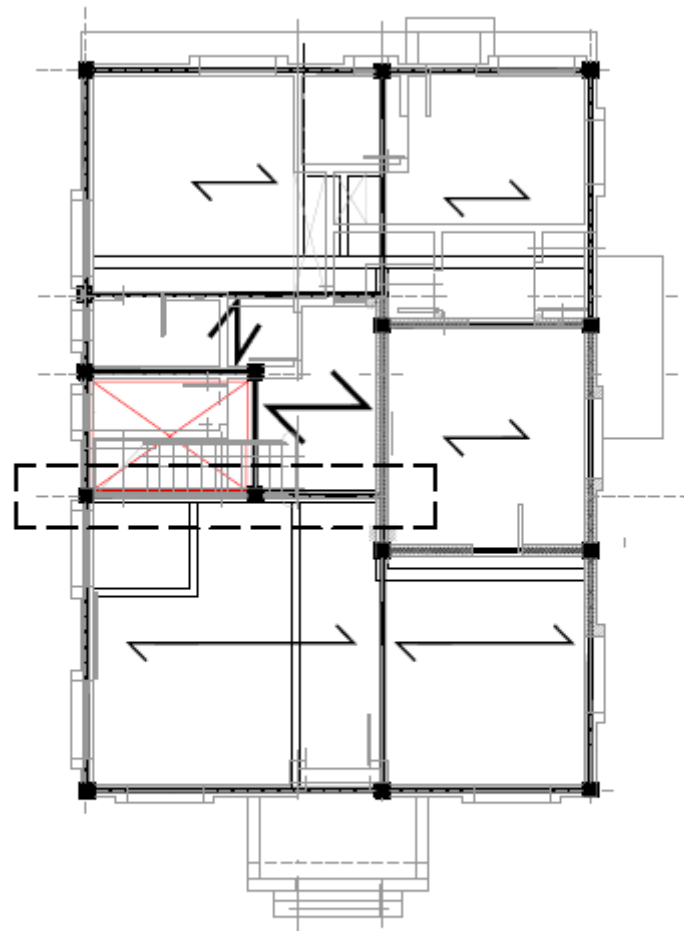
Method 1 Indicates - Provide **H12** at **100 c/c** As=1130mm².

Minimum Reinforcement = 0.13%*Ac=0.0013*(5720*150) = 1115.4mm²

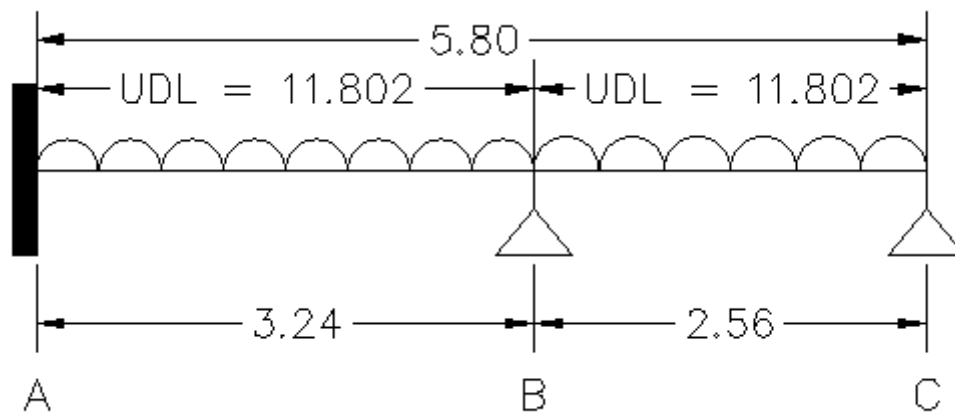
Maximum Reinforcement = 4%*Ac = 0.04*(5720*150)=34,320mm²

Analysis and Design of Two Span Continuous Beam

The chosen 2 span continuous beam will be identified as shown below.



GROUND FLOOR LAYOUT
U/S First Floor Support
SCALE 1:100



Beam Analysis

The above beam will be analysed utilising equilibrium equations with the reactive forces calculated and Shear Force and Bending moment diagram. The below equations will assume constant EI (EI=1)

Distribution Factor

Stiffness Coefficient - AB

$$AB(Kab) = \frac{4EI}{L} = \frac{4 * 1}{3.24} = \frac{4}{3.24} = 1.23$$

Stiffness Coefficient - BC

$$BC(Kbc) = \frac{3EI}{L} = \frac{3 * 1}{2.56} = \frac{3}{2.56} = 1.17$$

Distribution Factor BA

$$\frac{(Kab)}{kab + kbc} = \frac{1.23}{1.23 + 1.17} = 0.51$$

Distribution Factor BA

$$\frac{(Kbc)}{kab + kbc} = \frac{1.17}{1.23 + 1.17} = 0.49$$

Fixed End Moment

$$AB\ FEM_{ab} = \frac{WL^2}{12} = \frac{11.802 * 3.24^2}{12} = \frac{123.8926752}{12} = 10.3243896 = 10.32$$

$$BC\ FEM_{bc} = \frac{WL^2}{12} = \frac{11.802 * 2.56^2}{12} = \frac{77.3455872}{12} = 6.44454656 = 6.44$$

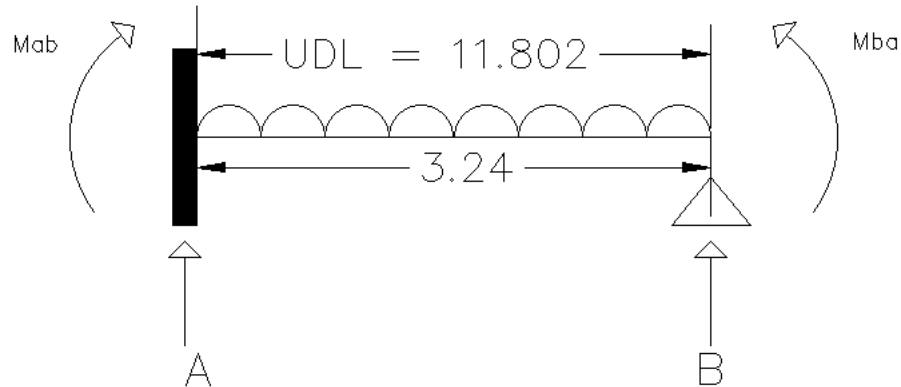
Balance Moments

Span	A	AB	BC	C
Distribution Factor	0	0.51	0.49	1
Fixed End Moment	10.320	-10.320	6.440	-6.440
Balance Moment	0	1.979	1.901	6.440
Carry Over (*0.5)	0.990	0	3.22	0.951
Balance Moment	0	-1.642	-1.578	-0.951
Carry Over (*0.5)	-0.821	0	-0.476	-0.789
Balance Moment	0	0.243	0.233	0.789
Carry Over (*0.5)	0.122	0	0.395	0.117
Balance Moment	0	-0.201	-0.193	-0.117
Carry Over (*0.5)	-0.101	0	-0.059	-0.097
Balance Moment	0	0.0301	0.029	0.097
Carry Over (*0.5)	0.015	0	0.049	0.015
Balance Moment	0	-0.025	-0.024	-0.015
Final Moment	10.525	-9.94	9.937	0

Support Reaction Calculations

Using Equilibrium Equations the following support reactions are calculated;

Span AB



Sum of Moment at B = 0

$$(V_{AB} * 3.24) - 10.525 - (11.802 * 3.24 * 1.62) + 9.94 = 0$$

$$3.24V_{ab} - 10.525 - 61.946 + 9.94 = 0$$

$$3.24V_{ab} - 62.531 = 0$$

$$V_{ab} = \frac{62.531}{3.24} = 20.844$$

Sum of Moment at A

Sum of Moment at A = 0

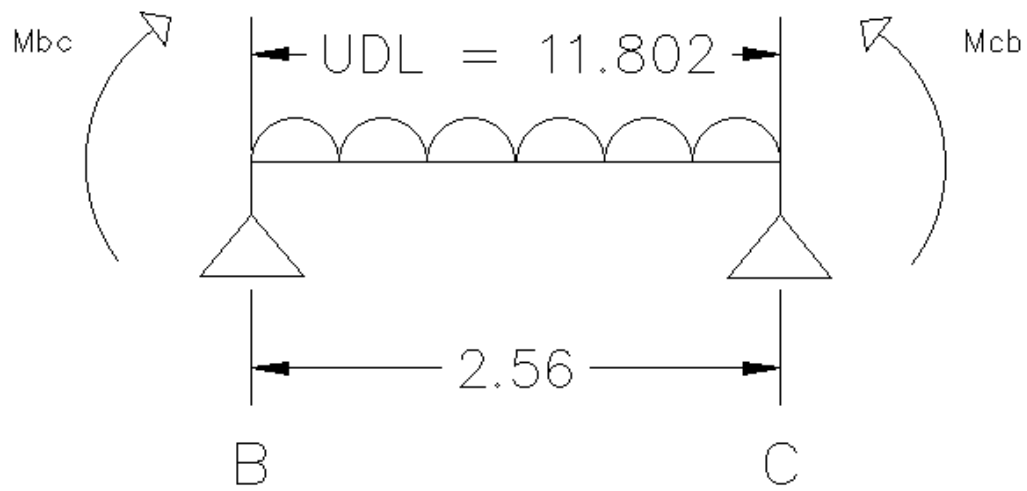
$$(V_{ba} * 3.24) + 9.94 + (3.24 * 11.802 * 1.62) + 10.525 = 0$$

$$3.24V_{ba} + 9.94 + 61.946 + 10.525 = 0$$

$$3.24V_{ba} + 82.411 = 0$$

$$V_{ba} = -\frac{82.411}{3.24} = 25.435$$

Span BC



Sum of Moment at C = 0

$$(V_{bc} * 2.56) - (11.802 * 2.56 * 1.28) + 7.786 = 0$$

$$2.56V_{bc} - 46.459 = 0$$

$$V_{bc} = \frac{46.459}{2.56} = 18.148$$

Sum of moment at B

Sum of Moment at B = 0

$$(-V_{bc} * 2.56) - (11.802 * 2.56 * 1.28) - 7.786 = 0$$

$$-2.56V_{bc} - 30.887 = 0$$

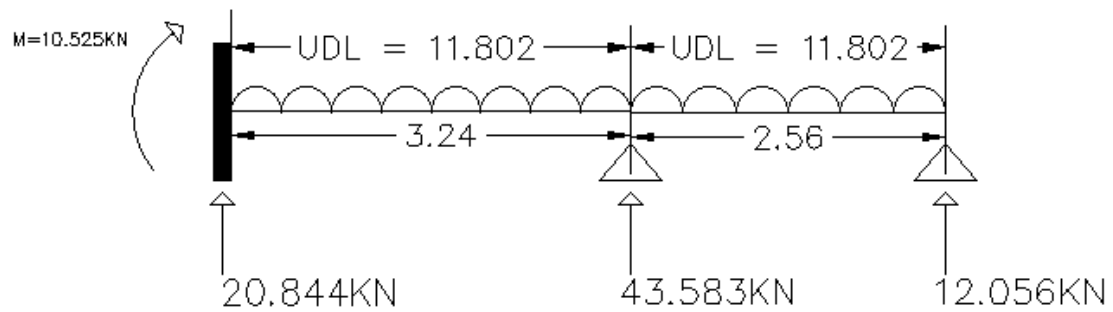
$$V_{bc} = \frac{30.887}{2.56} = 12.0652$$

Sum of reactions

$$V_a = 20.844$$

$$V_b = 25.435 + 18.148 = 43.583$$

$$V_c = 12.0562$$

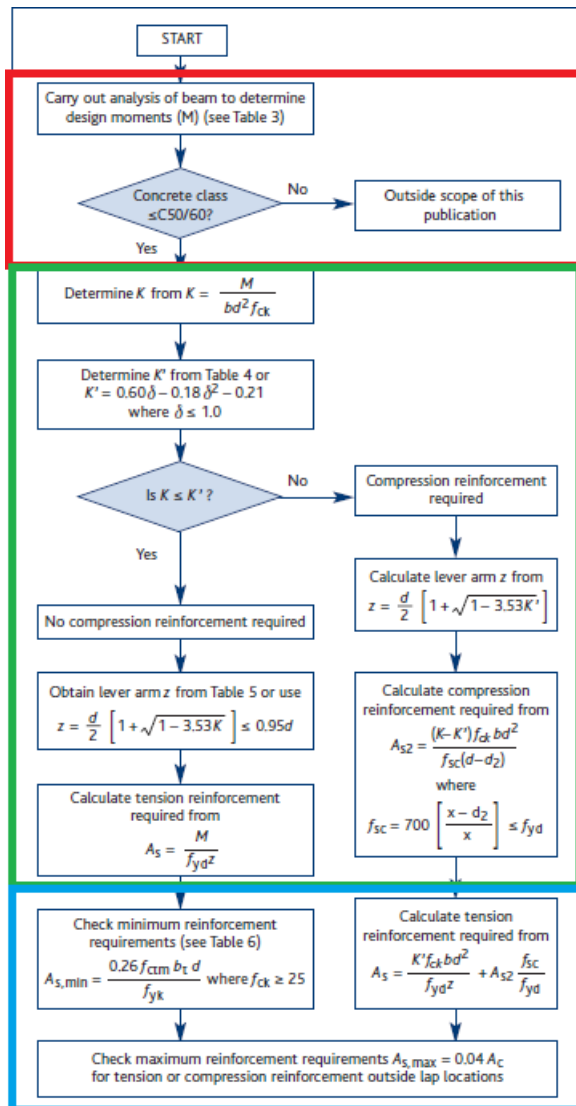


Shear Moment and Bending Moment Calculation

@ Point A	SF0=0 or 20.844	BM0 = 10.525
@1m From A	SF1=20.844-11.802*1=9.042	BM1 = 10.525+(20.844*1)- ((11.802*1)*0.5)=25.468
@2m From A	SF2=20.844-11.802*2= -2.76	BM2 = 10.525+(20.844*2)- (11.802*2)*1)=28.609
@3m From A	SF3=20.844-11.802*3= -14.562	BM3 = 10.525+(20.844*3)- ((11.802*3)*1.5)=19.948
@3.24m From A	SF3.24=20.844-11.802*3.24=- 17.395 Or	BM3.24 = 10.525+(20.844*3.24)- ((11.802*3.24)*1.62)=16.113

	$SF2=20.844-$ $11.802*3.24+43.583=26.189$	
@4m From A	$SF4=20.844-$ $(11.802*3.24)+43.4383-$ $(11.802*0.76)= 17.074$	$BM4 = 10.525+(20.844*4)-$ $((11.802*3.24)*1.56)-$ $((11.802*0.76)*0.38)=30.8405$
@5m From A	$SF5=20.844-$ $(11.802*3.24)+43.4383-$ $(11.802*1.76)=5.2723$	$BM5 = 10.525+(20.844*5)-$ $((11.802*3.24)*2.56)-$ $((11.802*1.76)*0.88)=-1.4245$
@5.18m From A	$SF51.8=20.844-$ $(11.802*3.24)+43.4383-$ $(11.802*2.56)=-4.1693$ OR $SF51.8=20.844-$ $(11.802*3.24)+43.4383-$ $(11.802*2.56)+12.506=8.3367$	$BM5 = 10.525+(20.844*5.18)-$ $((11.802*3.24)*3.56)-$ $((11.802*1.76)*1.28)+12.506=-$ 31.7136

Beam Design

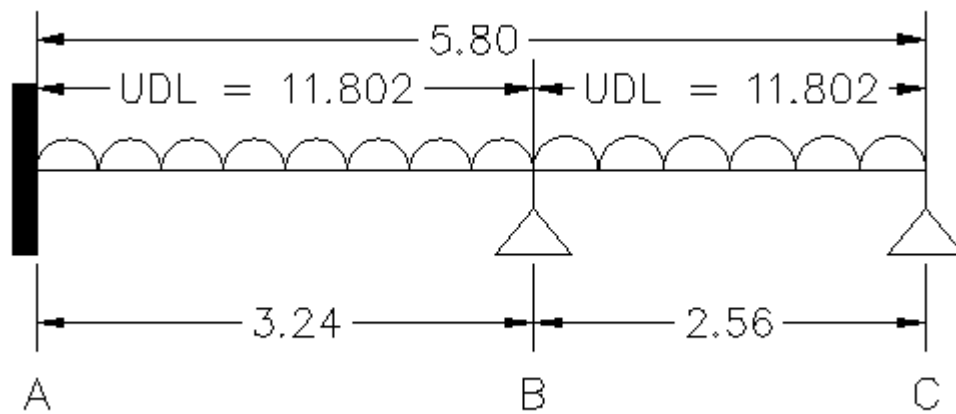


The process will be divided into 3 sections'

- Section 1 – (Highlighted Red) Analysis of the slab
- Section 2 – (Highlighted Green) – Calculation of K Prime, and Moments acting on proposed slab
- Section 3 – (Highlighted Blue) – Calculation of Reinforcement required (min and max)

Figure 3 - Beam Design Process (Bond et al., n.d.) pp.27

Section 1



Dead Load

$$\begin{aligned} \text{Slab } gk + \text{Roof } gk + \text{Beam SW} &= 5.18 + 1 + ((0.45 * 0.225) * 24) = 5.18 + 1 + 2.43 \\ &= 8.61 \text{KN/m}^2 \end{aligned}$$

Live Load

$$\text{Slab } qk + \text{Roof } qk = 1.5 + 0.6 = 2.1 \text{KN/m}^2$$

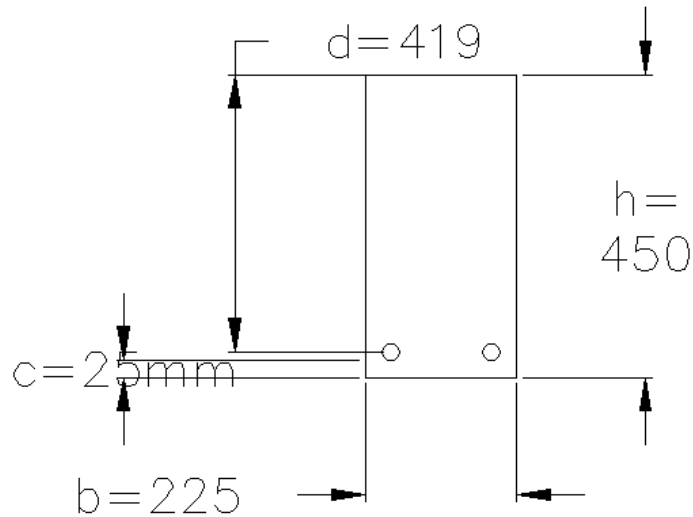
Ultimate Limit Load

$$1.4gk + 1.6qk = (1.4 * 8.61) + (1.6 * 2.1) = (12.054) + (3.36) = 15.414 \text{KN/m}^2$$

Section 2

Design Moment (M)

$$M = \frac{wL^2}{8} = \frac{15.414 * 5.80^2}{8} = \frac{518.52696}{8} = 64.81587 = 64.816 \text{ KN/m}^2$$



Fck	40Nmm ²
Design Life	100 Years
Exposure Condition	XS1 – Near Sea
Cover	25mm
Fcu	25

$$d = h - \left(\frac{\varnothing bar}{2} \right) - c = 450 - \left(\frac{12}{2} \right) - 25 = 419 \text{ mm}$$

Equation above M is in KN/m², this needs to be converted into Nmm, this is achieved by multiplying M E 6.

$$M = 64.816 * 10^6 = 64816000$$

$$K = \frac{M}{F_c b d^2} = \frac{64816000}{25 * 225 * 419^2} = \frac{64816000}{987530625} = 0.065634 = 0.066$$

$$K_{prime} = 0.156$$

$$K = < 0.156$$

Finding Z

$$Z = 0.95d = 398.05$$

Z is less than the amount indicated, as such it will be used to calculate the required steel reinforcement.

Section 3

$$A_s = \frac{M}{F_y d * Z} = \frac{64816000}{500 * 398.05} = \frac{64816000}{119025} = 325.6676 = 325.667 \text{ mm}^2$$

From Table 3.10, as shown below, the recommended reinforcement is to;

Table 3.10 Cross-sectional areas of groups of bars (mm²)

Bar size (mm)	Number of bars									
	1	2	3	4	5	6	7	8	9	10
6	28.3	56.6	84.9	113	142	170	198	226	255	283
8	50.3	101	151	201	252	302	352	402	453	503
10	78.5	157	236	314	393	471	550	628	707	785
12	113	226	339	452	566	679	792	905	1020	1130
16	201	402	603	804	1010	1210	1410	1610	1810	2010
20	314	628	943	1260	1570	1890	2200	2510	2830	3140
25	491	982	1470	1960	2450	2950	3440	3930	4420	4910
32	804	1610	2410	3220	4020	4830	5630	6430	7240	8040
40	1260	2510	3770	5030	6280	7540	8800	10100	11300	12600

Figure 4 - Cross Sectional Area of Groups of Bars for Beam Design

Based on the above table, the recommendation is to provide 3H12: $A_s = 339 \text{ mm}^2$.

This is further supported when calculating the minimum and maximum reinforcement as shown below;

$$\text{Minimum Reinforcement} = 0.13\% \cdot A_c = 0.0013 \cdot (225 \cdot 450) = 131.625 \text{ mm}^2$$

$$\text{Maximum Reinforcement} = 4\% \cdot A_c = 0.04 \cdot (225 \cdot 450) = 4,050 \text{ mm}^2$$

Analysis and Design of Column

Skip process and utilise Engineer's choice for design of concrete Pad foundation using the expected loads on the foundation.

Design of Reinforced Concrete Pad Footing for above Column

Dimensions of Column is assumed to be 350*350mm. In order to carry out the design of the concrete pad footing for the column located at B (see Beam Analysis), the below engineered assumptions will be carried out.

Column will transfer the Expected Dead Load and Live load from the above floors, it will transfer the total weight of concrete slab (floor one), and will transfer the SW of Beams AB and BC for half their length.

As such the total Dead Load (gk) for the pad footing will be made up of the below;

- Roof
 - $1\text{KN/m}^2 * 10 = 10\text{KN/m}^2$
- Slab
 - $5.8\text{KN/m}^2 * 10 = 58\text{KN/m}^2$
- Beams
 - Beam 1
 - $((0.45 * 0.225) * 2.817) * 24 = 6.84531$
 - Beam 2
 - $((0.45 * 0.225) * 1.15) * 24 = 2.7945$
- Column
 - $((0.35 * 0.35) * 2.5) * 24 = 7.35$

Total Assumed Dead Load = $10 + 58 + 6.84531 + 2.7945 + 7.35 = 84.98981$, rounded up to 85KN.

The bearing pressure on the soil is assumed to be 200KN/m^2

Using prescriptive methods as outlined in Category 2. The base area would be;

Assumed Live Load

- Roof
 - $0.6\text{KN/m}^2 * 10 = 6\text{KN/m}^2$
- Slab First Floor
 - $1.5\text{KN/m}^2 * 10 = 15\text{KN/m}^2$

Total Assumed Live load is $6 + 15 = 21\text{K}$

The presumed bearing pressure of the non-aggregate soil is 200KN/m^2

$$\text{Base Area} = \frac{85 * 21}{200} = \frac{106}{200} = 0.53\text{m}^2$$

*so 1m * 1m base * 0.25m (say) deep*

Loading

$$= (1.4 * 85) + (1.6 * 21) = 119 + 33.6 = 152.6\text{Kn}$$

ULS Bearing Pressure

$$= 152.6 / 1\text{m}^2 = 152.6\text{KN/m}^2$$

Med

$$\frac{152.6 * 1 * 0.825^2}{2} = 103.863375 = 103.86\text{KNm}$$

(Process stopped as unable to follow notes for above process)

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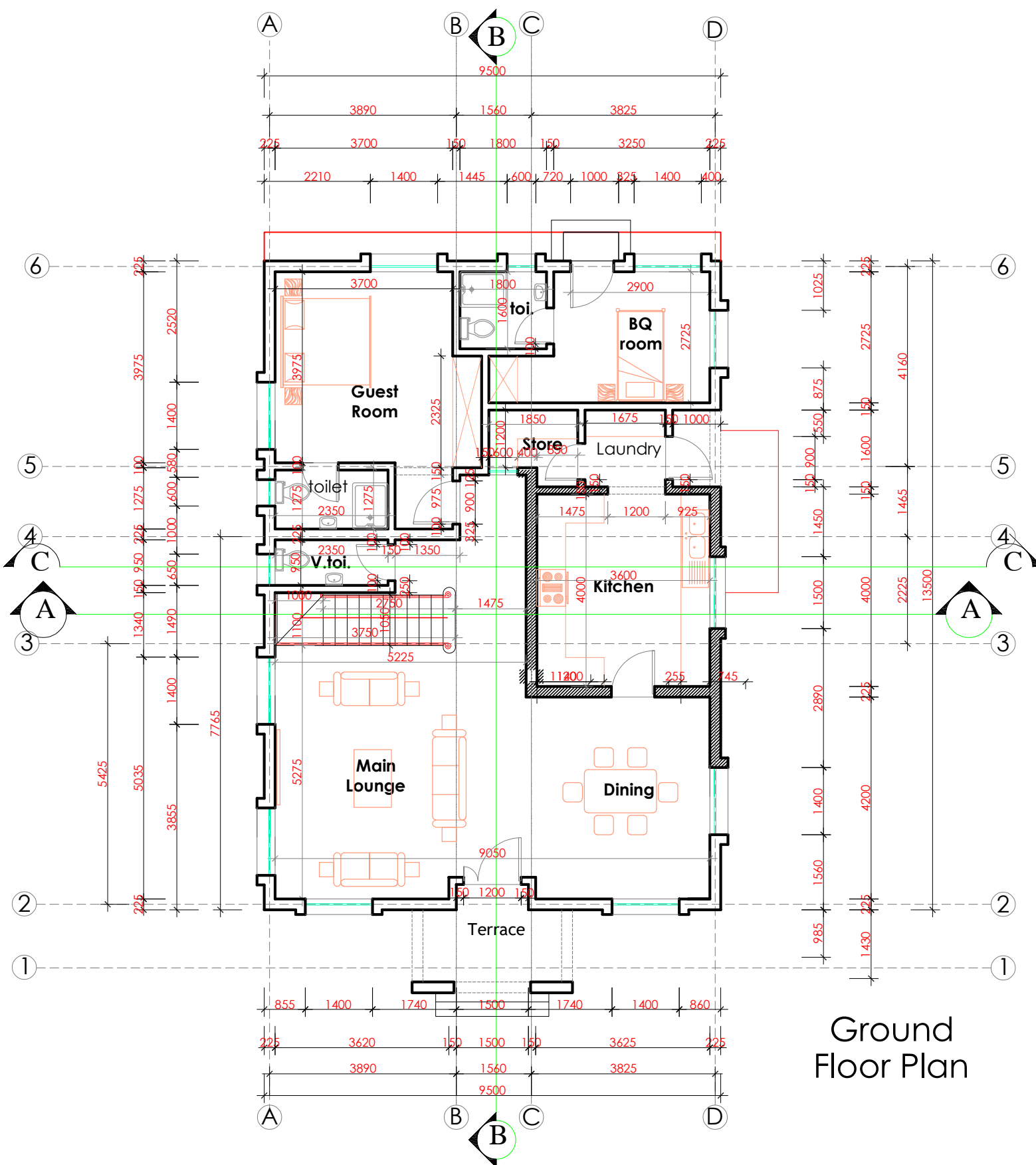
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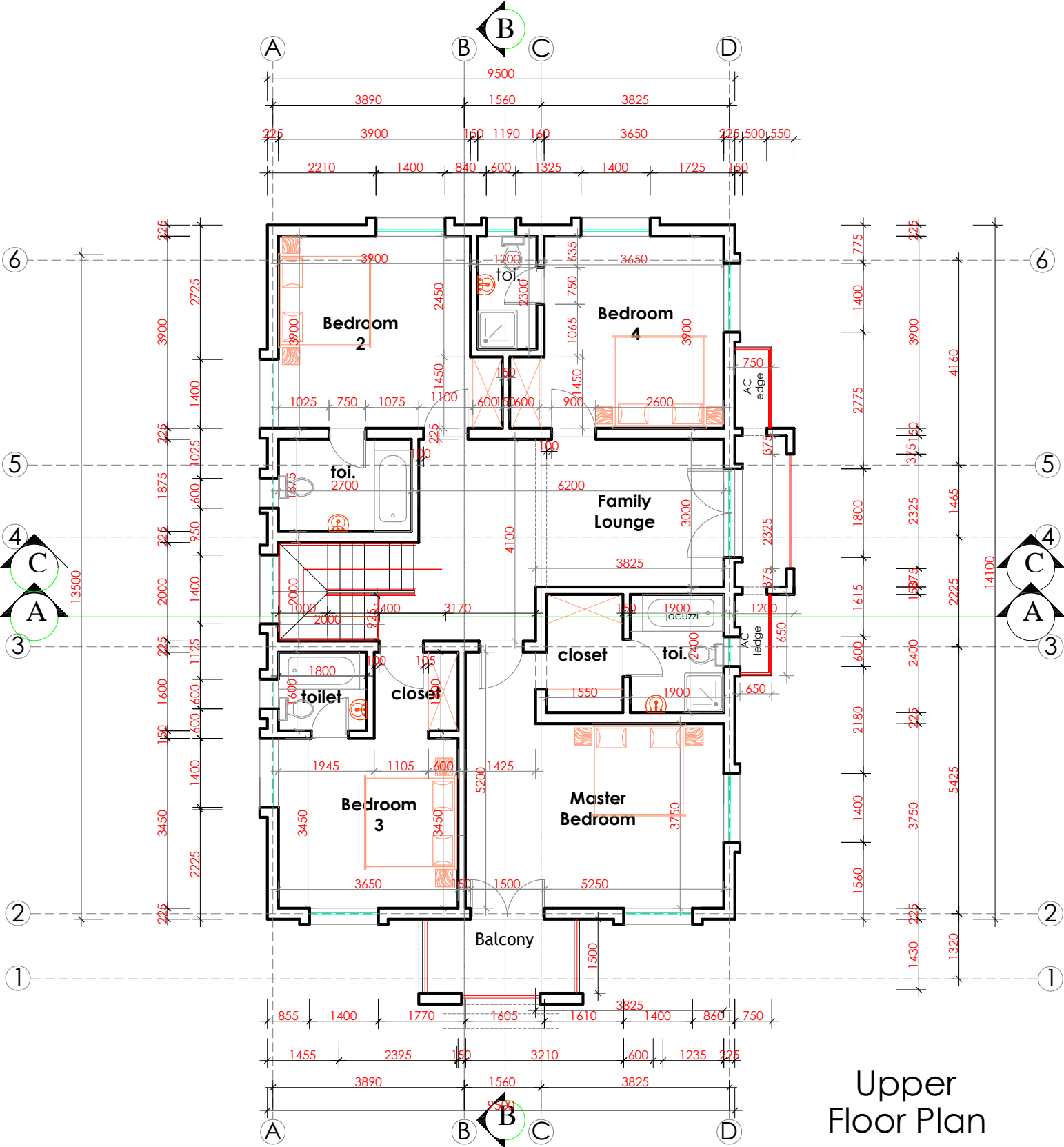
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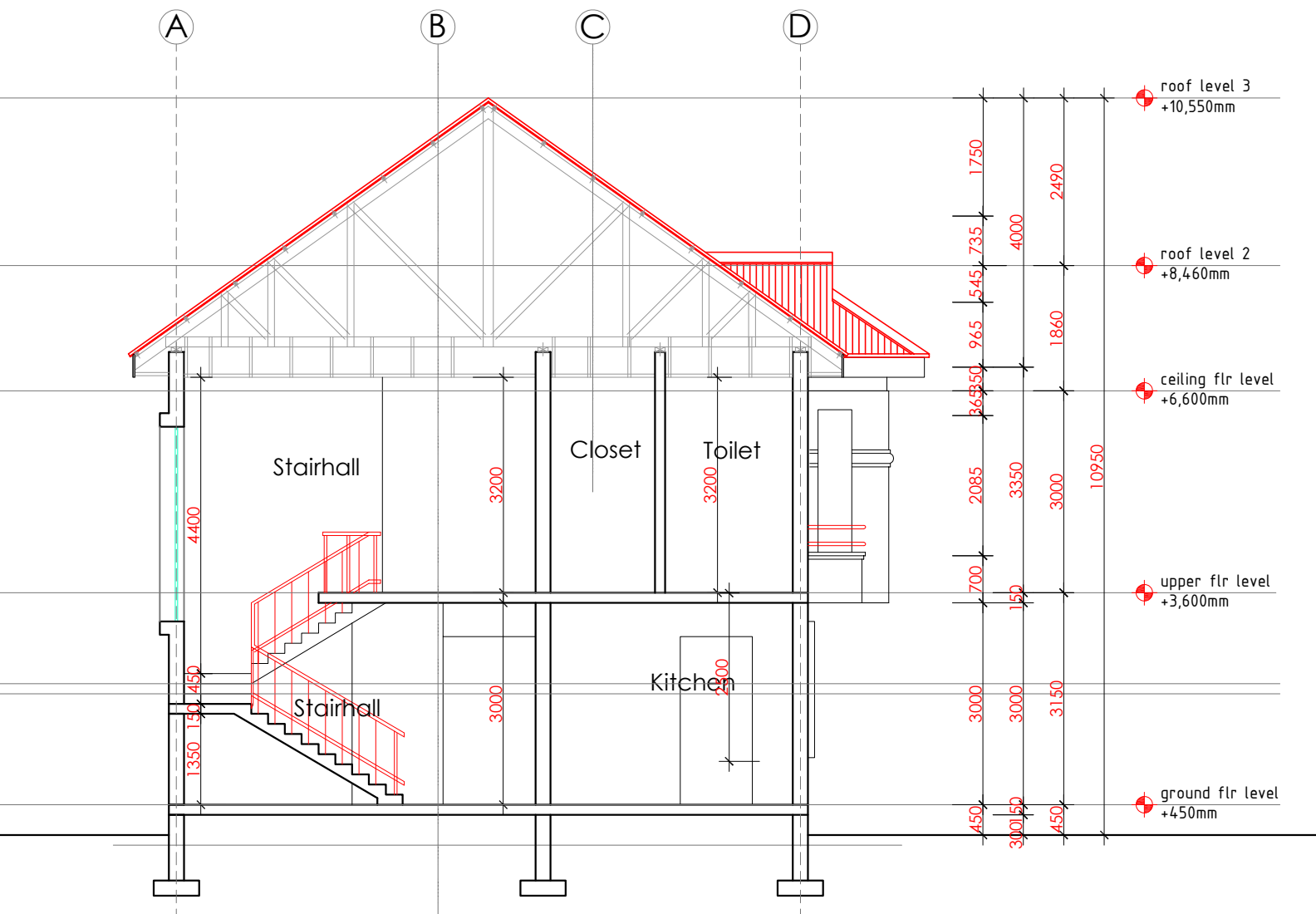
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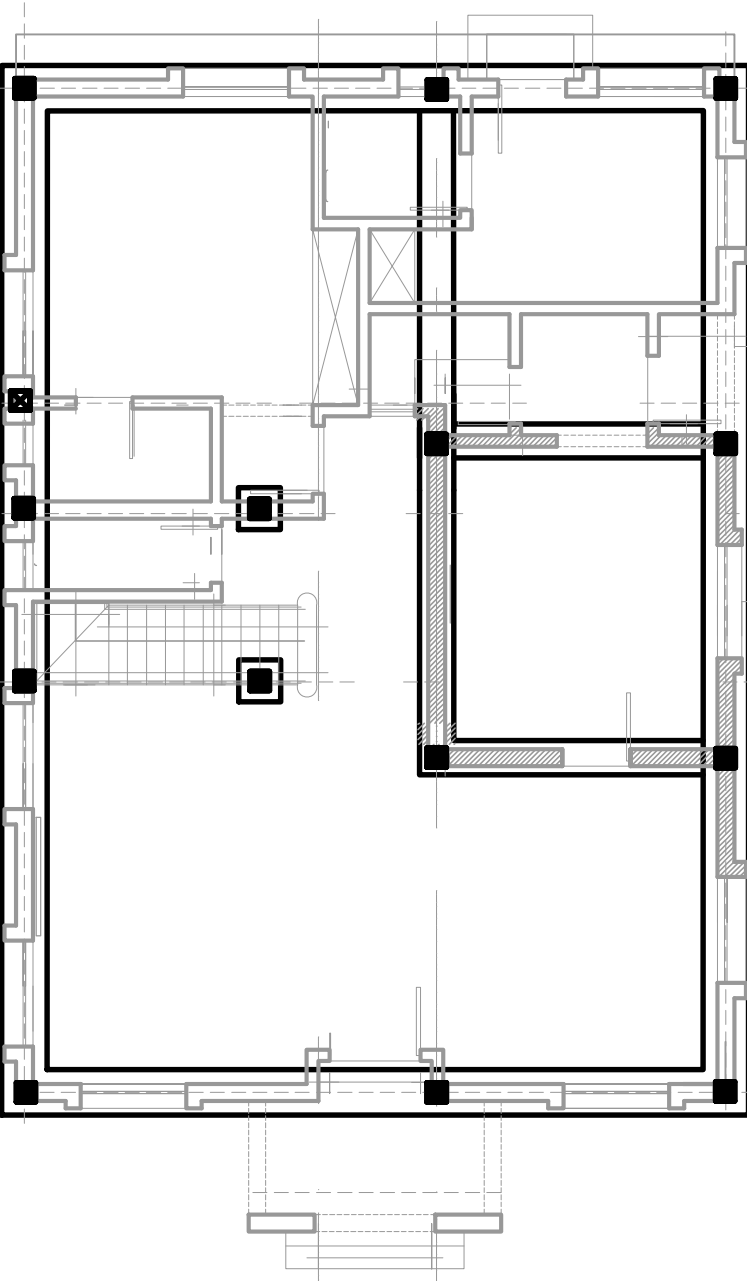


Ground Floor Plan

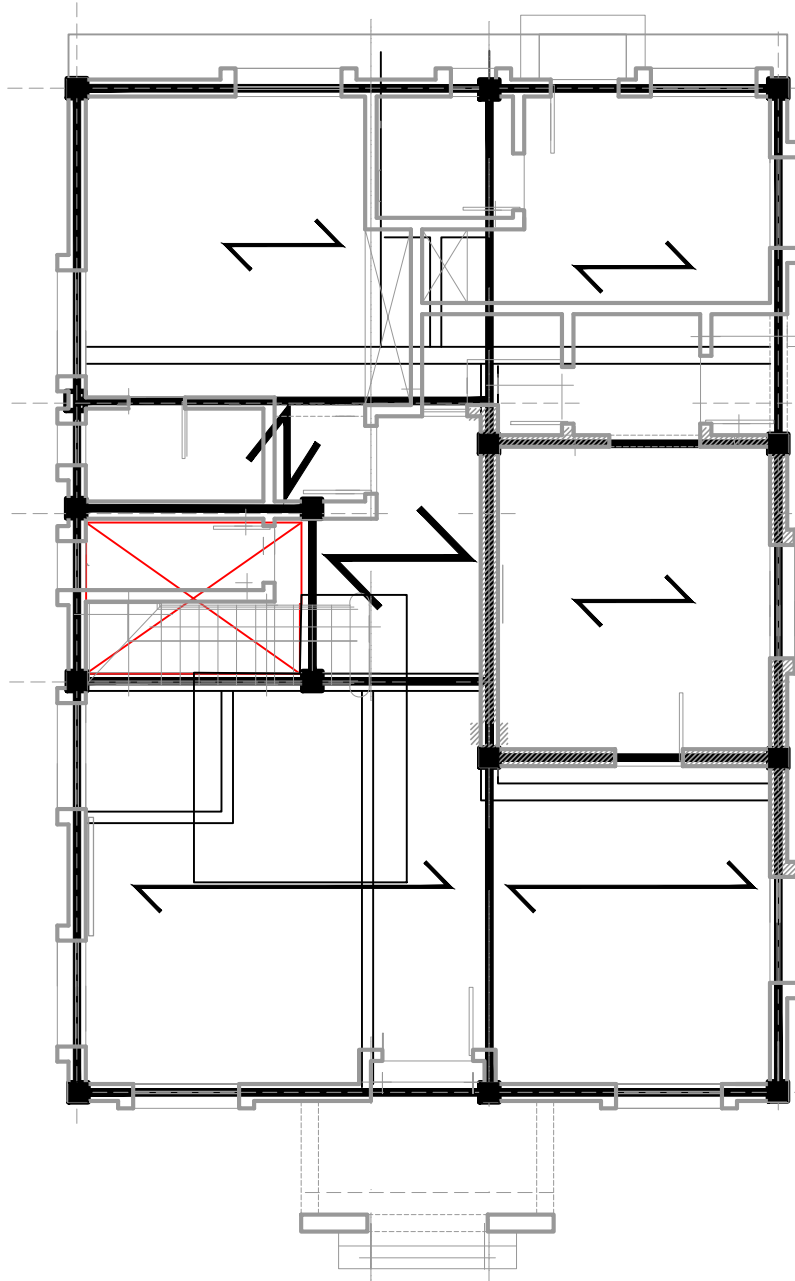


Upper Floor Plan

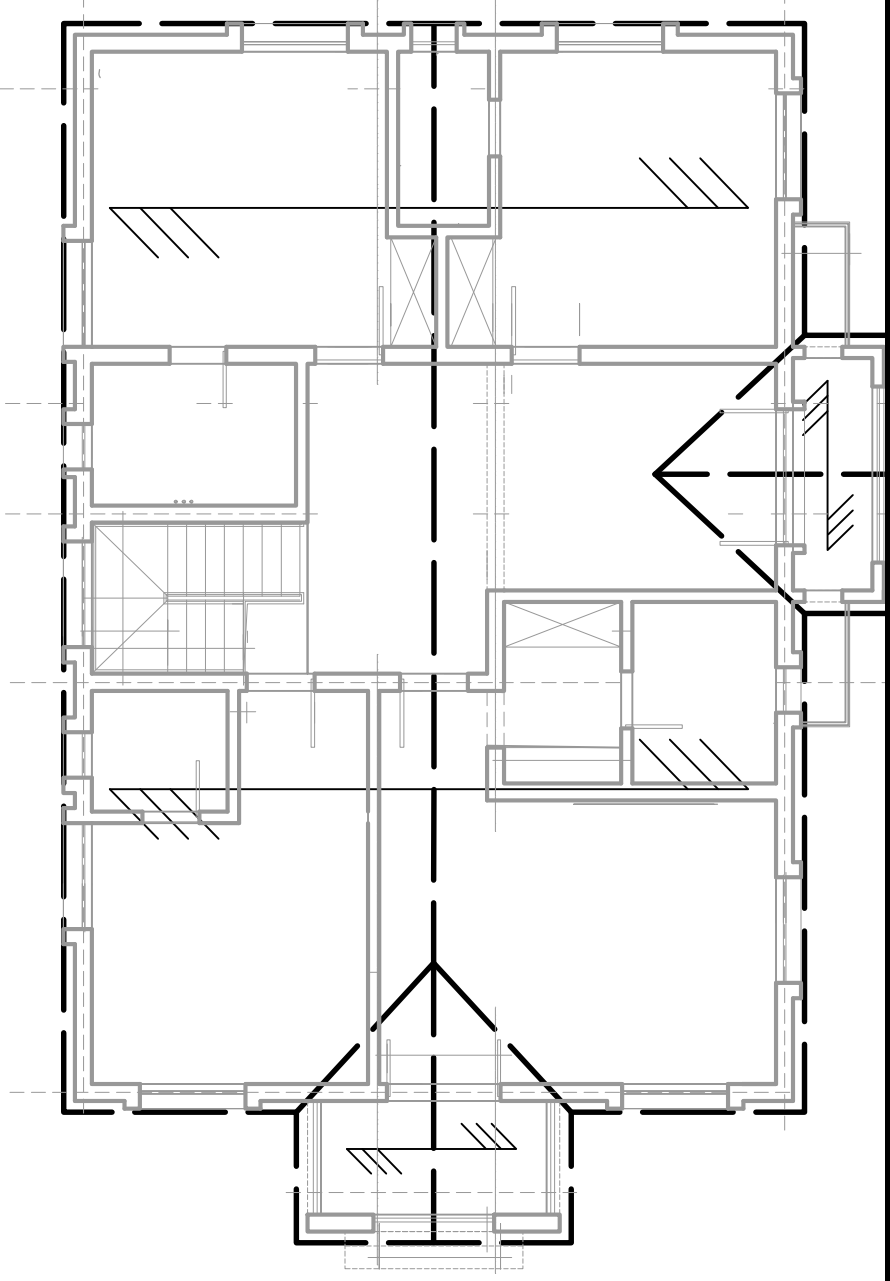




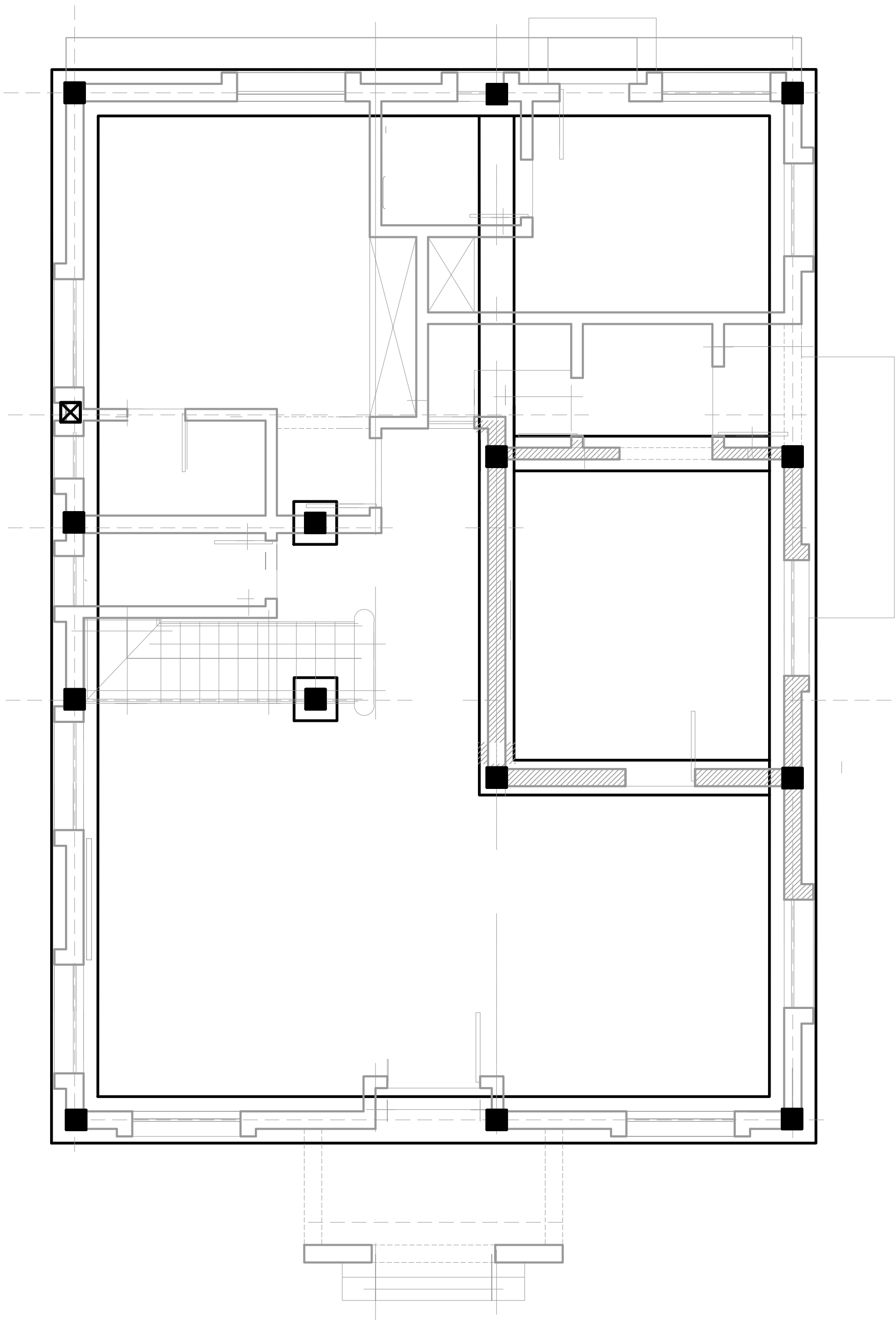
FOUNDATION GA AND
COLUMN LOCATION
SCALE 1:100



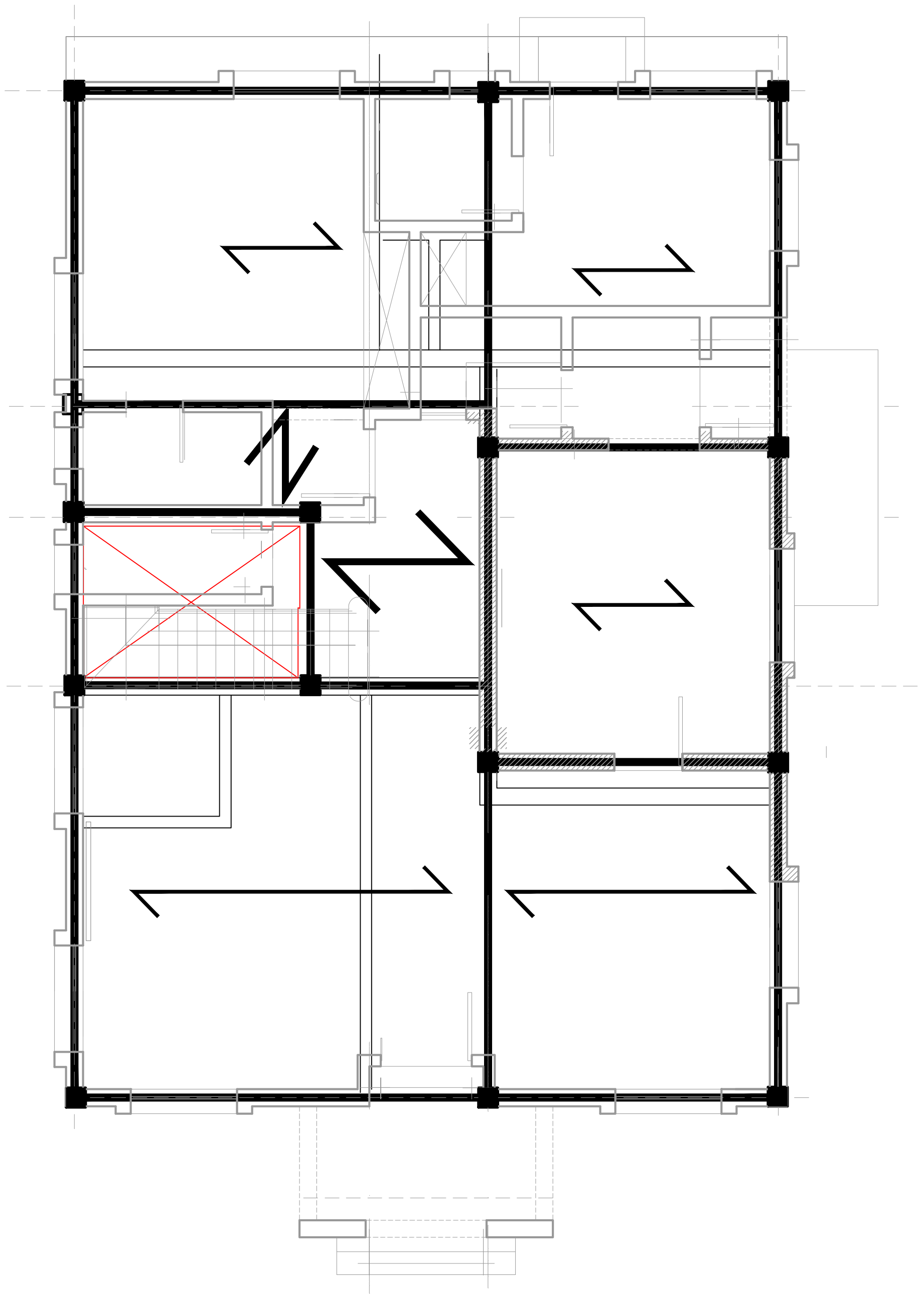
GROUND FLOOR LAYOUT
U/S First Floor Support
SCALE 1:100



ROOF
SCALE 1:100



FOUNDATION GA AND
COLUMN LOCATION



GROUND FLOOR LAYOUT
U/S First Floor Support