BEAM LOAD CALCULATIONS

(1) First floor Beam 3/B-C

i) Self weight of the Beam → Dead Load
ii) Brick Wall → Dead Load
iii) Dead Load and Live Load from Slabs

Dead Load a) Slab 3-4/B-C
b) Slab 2-3/B-C

Live load a) Slab 3-4/B-C
b) Slab 2-3/B-C

---

i) Self weight of the Beam

Self weight = Beam size × concrete density
= 0.15 × 0.3 × 24
= 1.08 kN/m.

ii) Self weight of Brick Wall

Brickwall weight = wall height × thickness × density
= 3.3 × 0.15 × 19
= 9.41 kN/m

---

iii) Dead Load ~~and Live load~~ from slabs

a) Dead Load from slab 3-4/B-C (2 way)

* Load transfered in triangular form

Deadl Load from Slab = Dead Load on slab × $(L_x/2)$ × $(2/3)$ factor
= 2.4 × 1/2 × 2/3
= 0.8 kN/m

b) Dead load from Slab 2-3/B-C

* Load transfered in triangular form

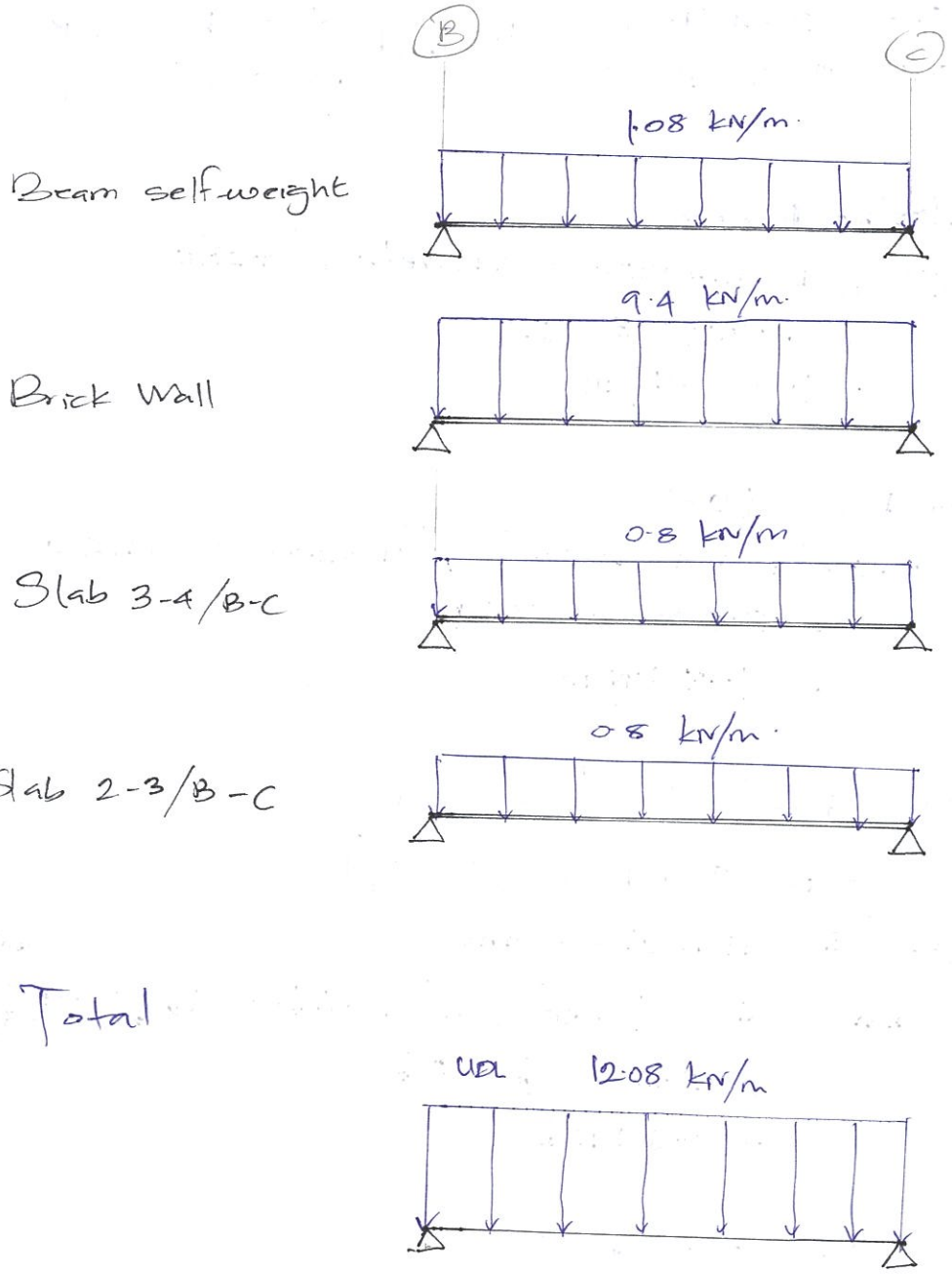
Deadl Load from Slab = Dead Load of slab × $(L_x/2)$ × $(2/3)$ Δ factor
= 2.4 × 1/2 × 2/3
= 0.8 kN/m

Total Dead Load

Total Load for 3/B-C = 1.08 + 9.4 + 0.8 + 0.8

= 12.08 kN/m

Total Dead Load Diagram



Total

iii) Live load from Slabs

a) Live load from slab 3-4/B-C (2way)

Load transfered in triangular form Ø factor

Live load = live load on slab × (lx/2) × (2/3)

= 2 kN/m² × (1/2 m) × 2/3

= 0.67 kN/m.

b) Live load from slab 2-3/B-C (2way)

Load transfered in triangular form

Live load = Live load on slab × (lx/2) × (2/3)

= 2 × 1/2 × 2/3

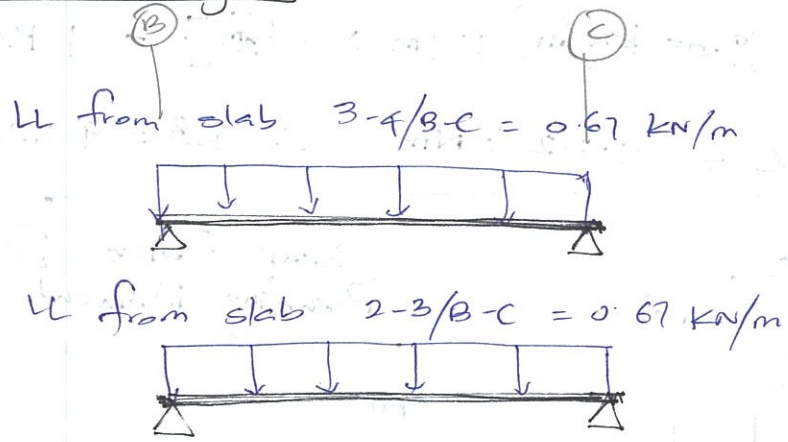
= 0.67 kN/m

Total live Load

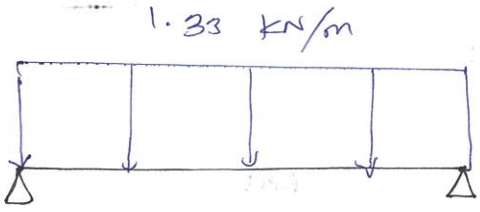
= 0.67 + 0.67

= 1.33 kN/m

Total Live Load Diagram



Total live load



ULTIMATE LOAD FOR BEAM 3/B-C

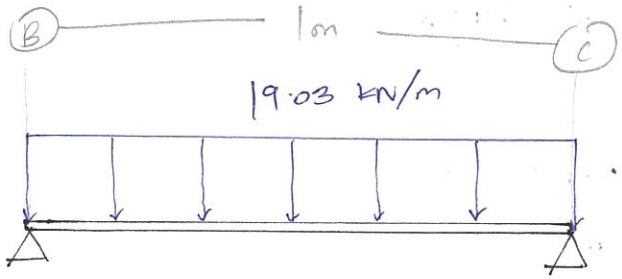
- Apply factor 1.4 and 1.6 to dead load and live load respectively

Dead Load B-C = 12.08 × 1.4 = 16.9 kN/m

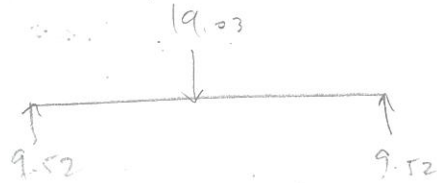
Live load B-C = 1.33 × 1.6 = 2.13 kN/m

Ultimate load for B-C = 16.9 + 2.13 = **19.03 kN/m**

Ultimate Load Digram for Beam 3/B-C



Ultimate load

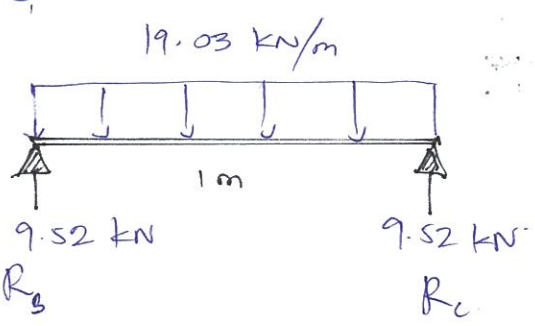


* Reactions

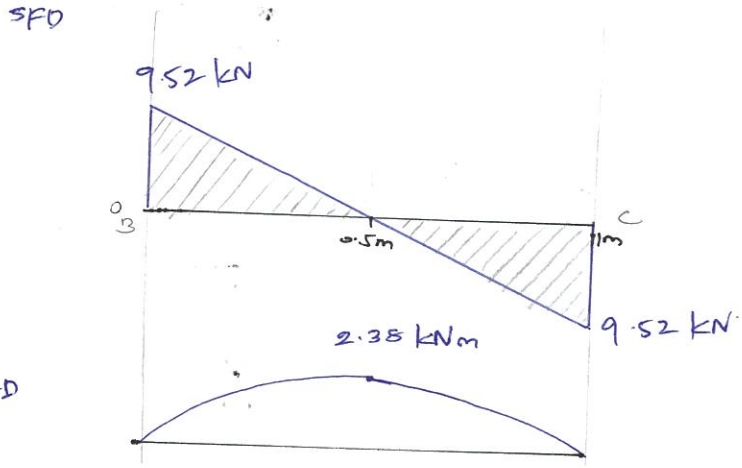
$$\Sigma M_B = [(19.03\ kN/m) \times 1m \times (1/2m)] - 1\,R_C = 0$$

$$R_C = 9.52\ kNm \quad \therefore R_B = 9.52$$

Load Diagram



Shear Force Diagram and Bending Moment Diagram



2 First Floor Beam C/2-4

i) Self weight of Beam → Dead Load
ii) Brick Wall → Dead Load
iii) Dead and Live load from Slabs
  a) Dead Load from Slab B-C/2-3 and BC/3-4
  b) Live Load from slab B-C/2-3 and B-C/3-4
iv) Point Load from Beam 3/B-C

---

i) Self weight of Beam
= Beam size × concrete density
= 0.15 × 0.3 × 24
= 1.08 kN/m

ii) Self weight of Brick Wall
= 3.3m × 0.15m × 19 kN/m³
= 9.41 kN/m

---

iii) a) Dead Load from Slab B-C/2-3 (two-way)
Load transfered in Triangular form
Dead Load = 2.4 kN/m × (1/2m) × (2/3) (Δ factor)
= 0.8 kN/m

Dead Load from Slab B-C/3-4 (two way)
Load transfered in Trapezoidal Form
Dead Load = 2.4 × (1/2)
= 1.2 kN/m

iii) b) Live load from Slab B-C/2-3

Load transfered in triangular form

Live load = Live load on slab × (Lx/2) × (2/3) ← Δ factor

= 2 kN/m² × 1/2 m × 2/3

= 0.67 kN/m

Live load from Slab B-C/3-4

Load transfered in ~~Triangular form~~ Trapezoidal form

Live Load = 2 kN/m² × 1/2 m

= 1 kN/m

iv) Point Load from 3/B-C

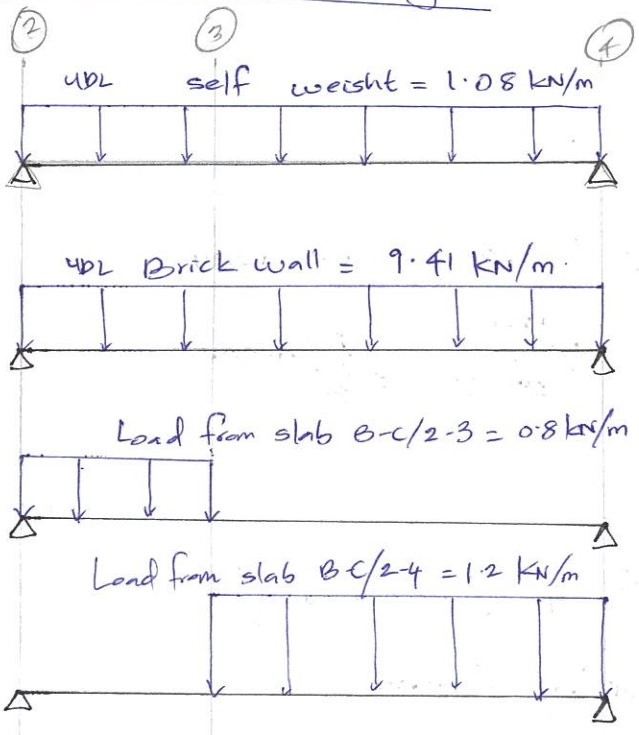
Ultimate Load from 3/B-C = 19.03 kN/m -

Length = 1m

Load = 19.03 × 1 = 19.03 kN/2 = R_c for beam 3-B-C

= 9.52 kN

Total Dead Load Diagram



~~Total live load Diagram~~

Total Dead Load

Total for 2-3 = 1.08 + 9.41 + 0.8

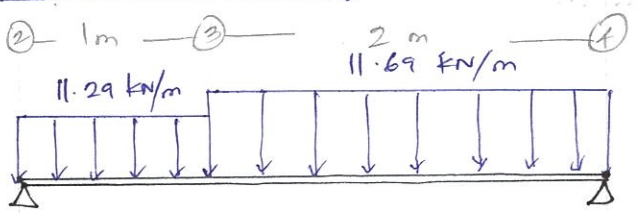
= 11.29 kN/m.

Total for 3-4 = 1.08 + 9.41 + 1.2

= 11.69 kN/m.

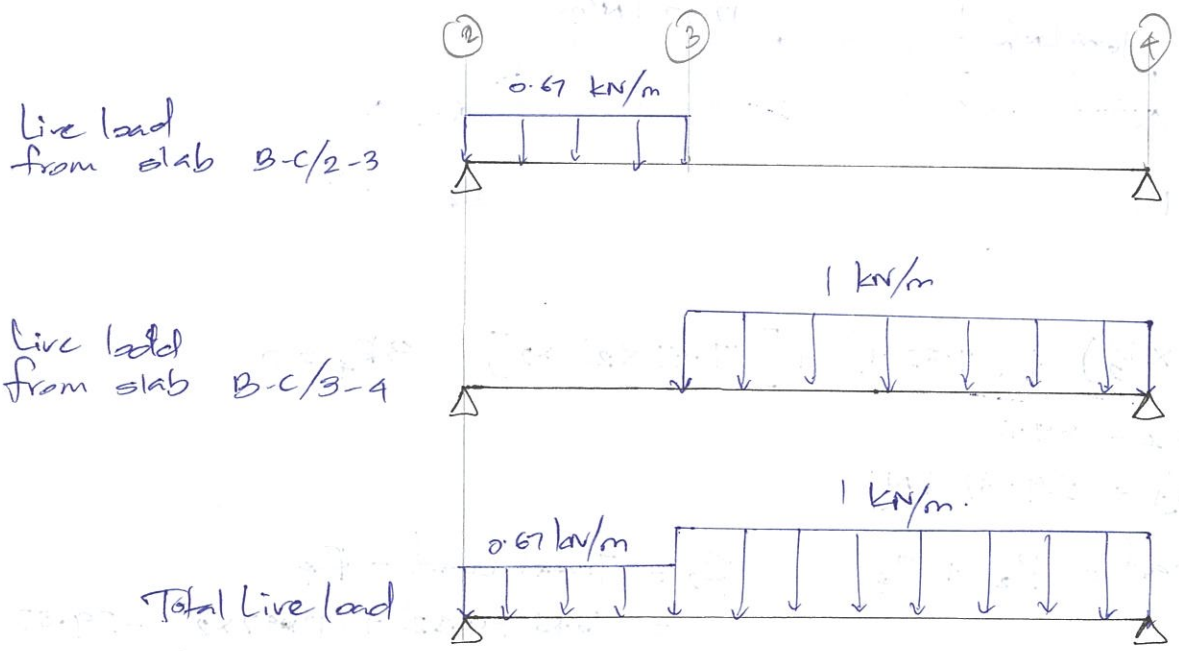
~~Total Dead Load Diagram~~

Total Dead Load



Total Live load Diagram

Total live load 2-3 = 0.67 kN/m
Total live load 3-4 = 1 kN/m



Ultimate Load for BEAM C/2-4

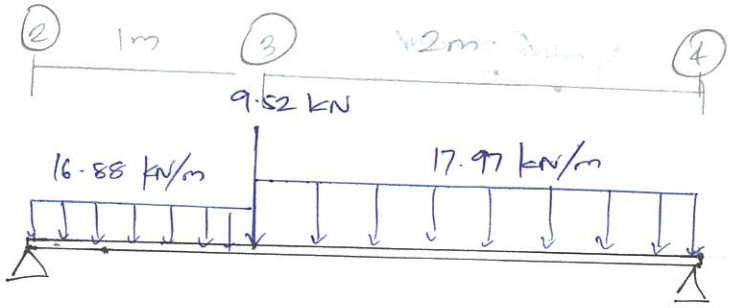
Apply factor 1.4 and 1.6 to dead load and live load respectively

* Dead Load 2-3 = 11.29 × 1.4 = 15.81 kN/m
  Dead Load 3-4 = 11.69 × 1.4 = 16.37 kN/m

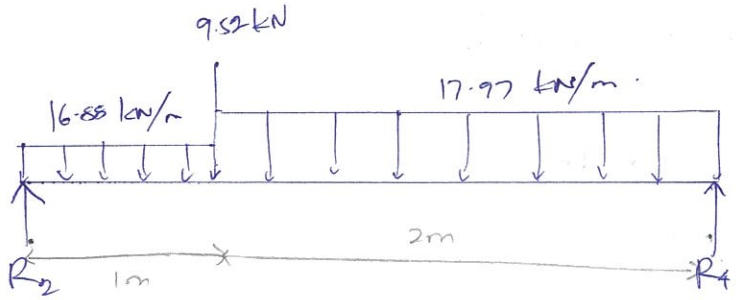
* Live Load 2-3 = 0.67 × 1.6 = 1.07 kN/m
  Live load 3-4 = 1 × 1.6 = 1.6 kN/m.

* Ultimate load 2-3 = 15.81 + 1.07 = 16.88 kN/m
* Ultimate load 3-4 = 16.37 + 1.6 = 17.97 kN/m

Ultimate Load Diagram



Reaction Forces for Beam C/2-4



$\Sigma M_2 = 0$

$[(16.88 \times 1/2) + (9.52 \cdot 1) + [(17.97 \times 2) \times 2] - 3R_4 = 0$

$3R_4 = 89.6$

$R_4 = 29.87$ kN

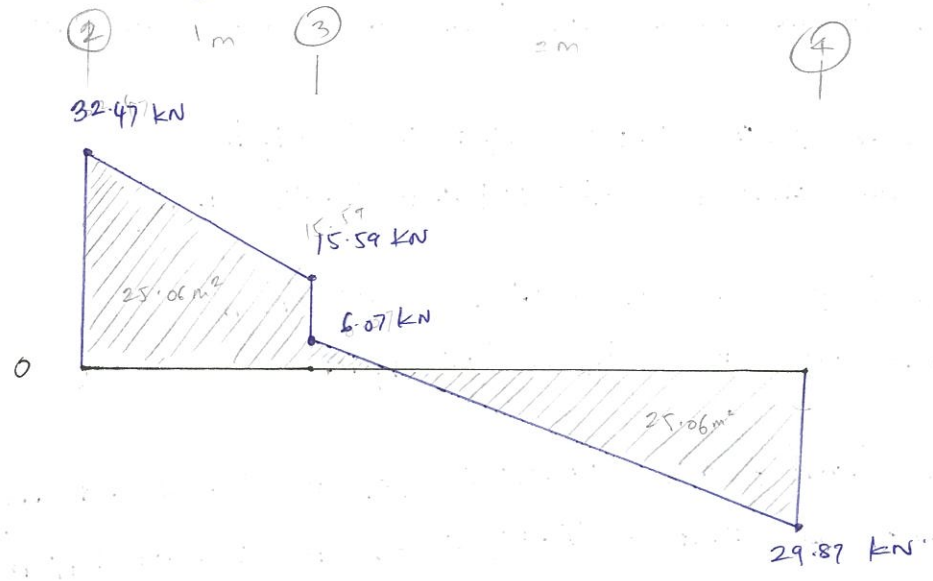
Total Load $= R_2 + R_4$

R_2 = Total Load $- R_4$

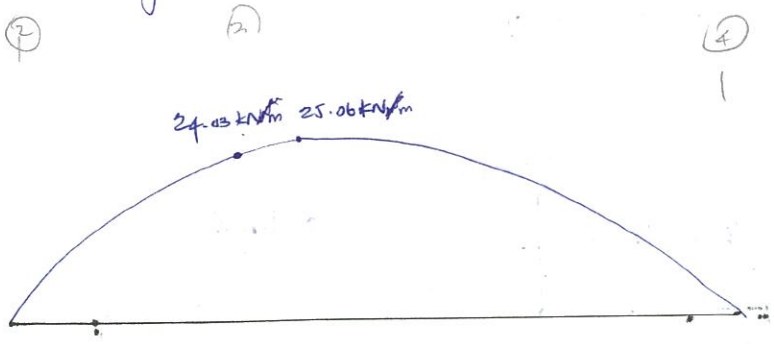
$= (16.88 + 9.52) + (17.97 \times 2) - 29.87$

$R_2 = 32.47$ kN

Shear Force Diagram



Bending Moment Diagram



(3) First Floor Beam B/2-4

i) Self weight of Beam → dead load

ii) Brick Wall → Dead Load.

iii) Dead and Live load from Slabs

a) Dead Load from slab B-C/3-4, BC/2-3 and AB/2-4

b) Live load from Slab B-C/3-4, B-C/2-3 and AB/2-4.

iv) Point Load from Beam 3/B-C

---

i) Self weight of Beam

= Beam size x concrete density

= 0.15 x 0.3 x 24 = 1.08 kN/m

ii) Self weight of Brick Wall (B 3-4)

= 3.3m x 0.15 x 19 kN/m³ = 9.41 kN/m

---

iii) a) Dead Load from Slab B-C/2-3 (two way)

Load transfered in Triangular form

Dead Load = 2.4 kN/m x 0.5m x (2/3) ← Δfactor

= 0.8 kN/m.

Dead Load from Slab B-C/3-4 (two way)

Load transfered in Trapezoidal form

Dead Load = 2.4 kN/m² x ½m

= 1.2 kN/m

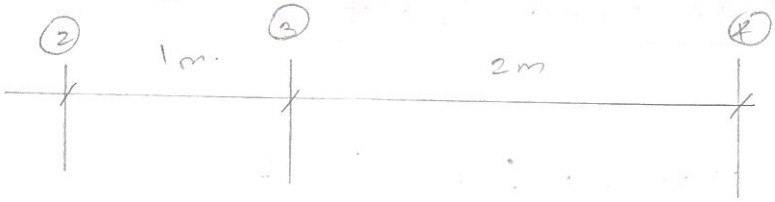
Dead Load from Slab A-B/2-4.

Load Transfered in Triangular form.

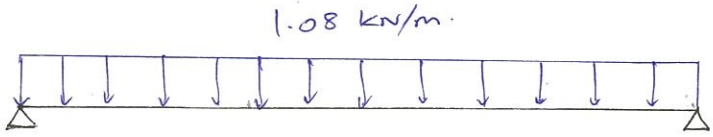
Dead Load = 2.4 kN/m² x 3/2 x (2/3) ← Δfactor

= 2.4 kN/m

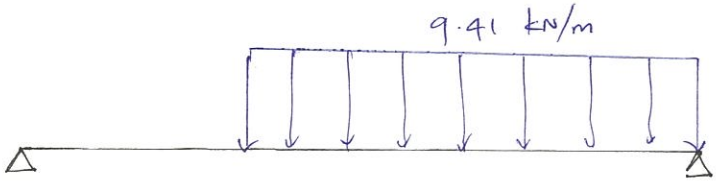
Total Dead Load Diagram



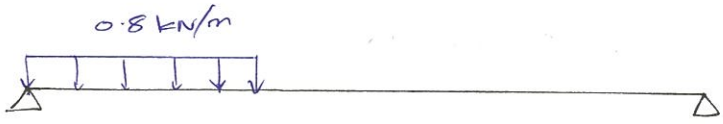
Self weight of Beam



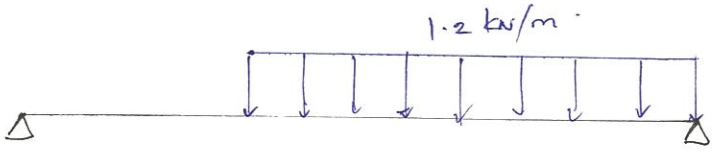
Self weight Brick wall



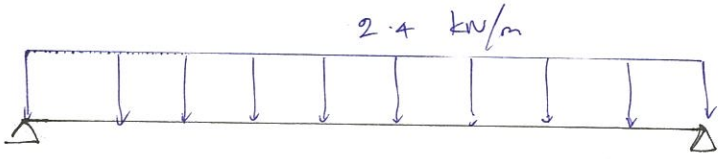
Slab B-C/2-3



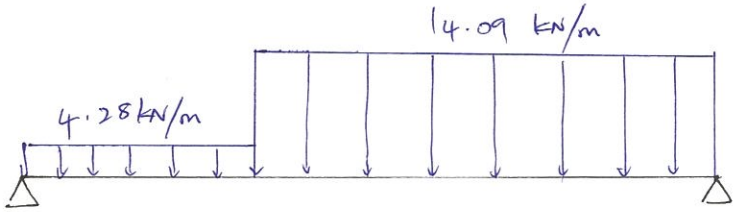
Slab B-C/3-4



Slab A-B/2-4



Total



Total Dead Load Calculations

Total for 2-3 = 1.08 + 0.8 + 2.4 = 4.28 kN/m

Total for 3-4 = 1.08 + 9.41 + 1.2 + 2.4 = 14.09 kN/m

iii) b) Live load from Slab B-C/2-3

Load transfered in triangular form

Live load = $2\ kN/m^2 \times 1/2 \times (2/3)^{\Delta factor}$

= $0.67\ kN/m$

Live load from Slab B-C/3-4

Load transfered in Trapezoidal Form

Live load = $2\ kN/m^2 \times 1/2\ m$

= $1\ kN/m$

Live load from Slab A-B/2-4

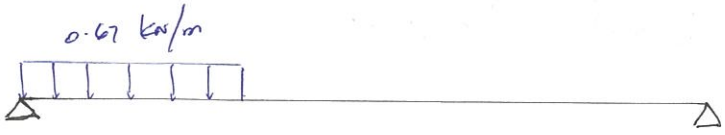
Load transfered in Triangular form

Live load = $2\ kN/m^2 \times (3/2m) \times (2/3)^{\Delta factor}$

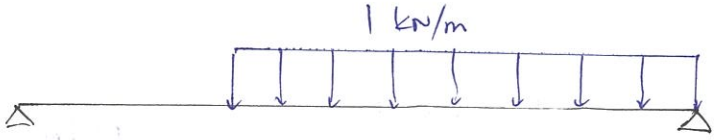
= $2\ kN/m$

Total Live Load Diagram

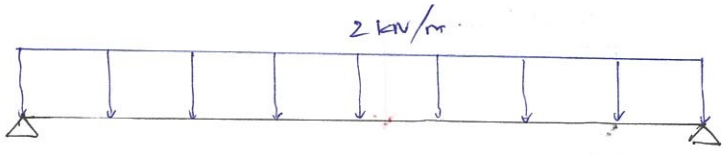
Slab B-C/2-3



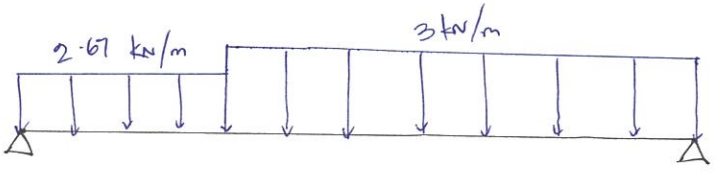
Slab B-C/3-4



Slab A-B/2-4



Total Live load



Total 2-3 = 0.67 + 2 = 2.67 kN/m

Total 3-4 = 1+2 = 3 kN/m

iv) Point Load from Beam 3/B-C

Point Load = R_B from beam 3/B-C

= 9.52 kN

ULTIMATE LOAD FOR BEAM B/2-4

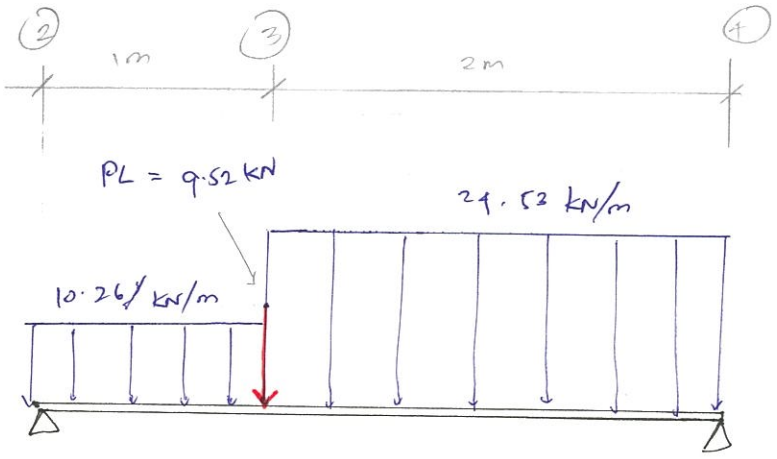
Apply factor 1.4 and 1.6 to dead load and live load respectively

* Dead Load 2-3 = 4.28 kN/m × 1.4 = 5.99 kN/m
* Dead Load 3-4 = 14.09 × 1.4 = 19.73 kN/m.

* Live load 2-3 = 2.67 × 1.6 = 4.27 kN/m
* Live Load 3-4 = 3 × 1.6 = 4.8 kN/m.

* Ultimate Load 2-3 = 5.99 + 4.27 = 10.26 kN/m
* Ultimate Load 3-4 = 19.73 + 4.8 = 24.53 kN/m

Ultimate Load Diagram



Reaction Forces for Beam B/2-4

$\Sigma M_2 = 0$

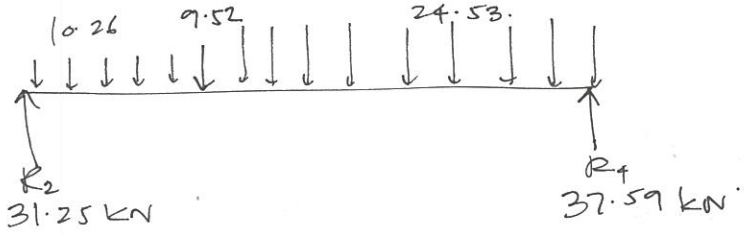
$$\left[(10.26 \times 1) \times \tfrac{1}{2}\right] + (9.52 \times 1) + \left[(24.53 \times 2) \times 2\right] - 3R_4 = 0$$

$$3R_4 = 5.13 + 9.52 + 98.12$$

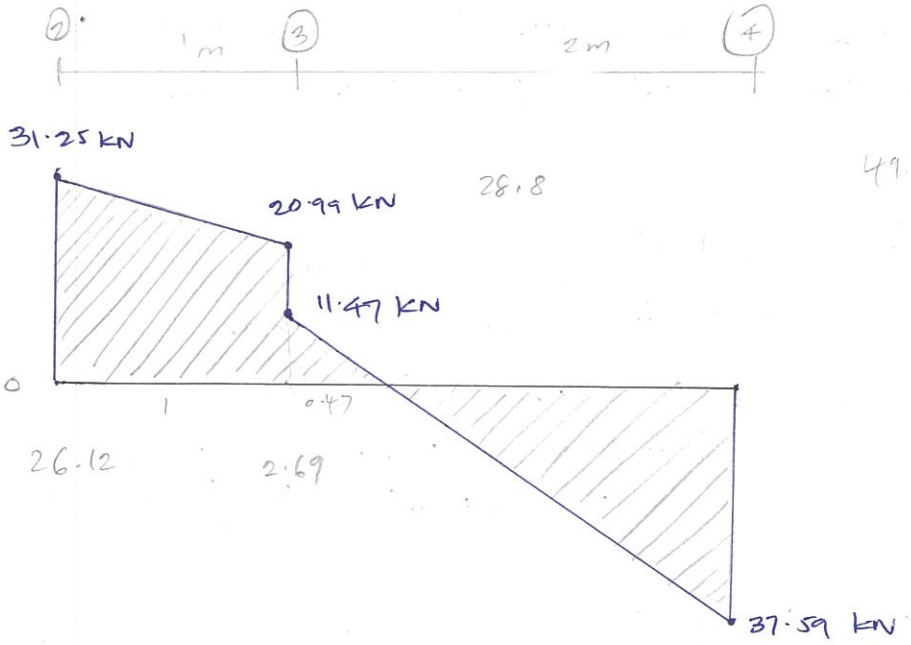
$$R_4 = 37.59 \text{ kN}$$

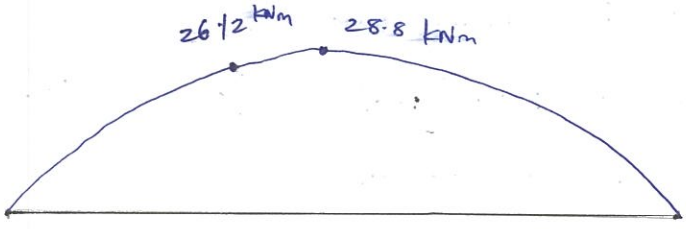
$$R_2 = \text{Total load} - R_4 = 10.26 + 9.52 + (2 \times 24.53) - 37.59$$

$$R_2 = 31.25 \text{ kN}$$



Shear Force Diagram





28.8

$$\frac{49.05}{11.47} = \frac{x}{x}$$

0.47 m

④ First Floor Beam A-C/4

i) Self weight of Beam → Dead load

ii) Brick Wall → Dead Load

iii) Deab and Live loads from Slabs

a) Dead Load from Slab A+B/2-4 and B-C/3-4.

b) Live load from Slab A-B/2-4 and B-C/3-4

iv) Point Load from Beam B/2-4

---

i) Self weight of Beam

= beam size x concrete density

= 0.15m x 0.3m x 24 kN/m³ = 1.08 kN/m

ii) Self weight Brick wall

= wall height x width x brick density

= 3.3 x 0.15 x 19 = 9.41 kN/m

iii) a) Dead Load from Slab A-B/2-4 (two way)

Load transfered in trapezoidal form

Dead Load = 3.6 kN/m² x (L_x/2)

= ~~2.4 x (3/2)~~

= 3.6 kN/m² x (3/2) = 5.4 kN/m

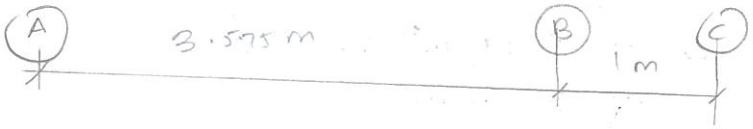
Dead Load from Slab B-C/3-4. (two way)

Load transfered in Triangular form

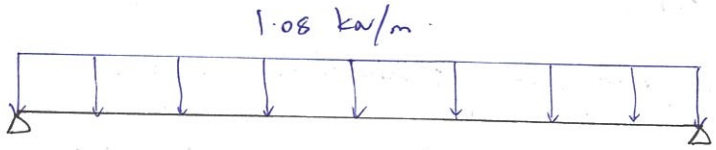
Dead Load = (2.4 kN/m²) x (1/2 m) x 2/3

= 0.8 kN/m

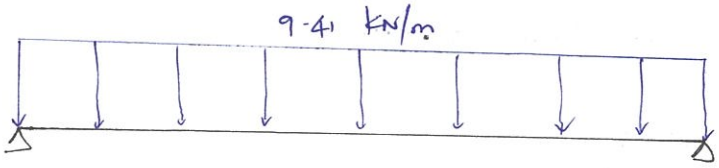
Total Dead Load Diagram



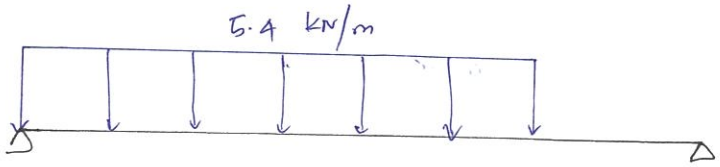
Self weight & beam



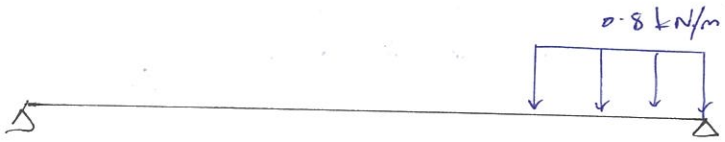
Brick wall



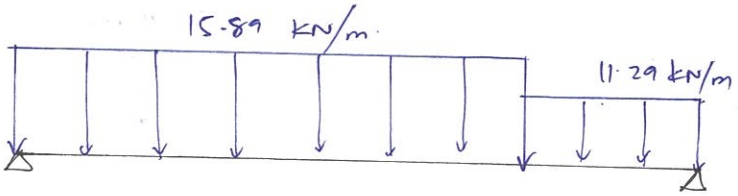
Slab A-B/2-4



Slab B-C/3-4



Total



Total Dead Load Calculation

Total for A-B = 1.08 + 9.41 + 5.4
= 15.89 kN/m

Total for B-C = 11.29 kN/m

iii) b) Live load from slab A-B/2-4 (two way)

Load transfered in trapezoidal form

Load = $2\ kN/m^2 \times (3/2)$

= $3\ kN/m$

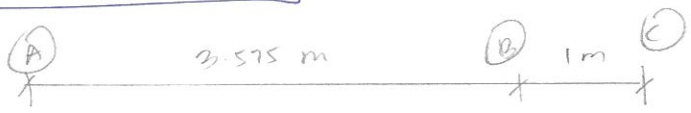
Live load from Slab B-C/3-4 (two way)

Load transfered in triangular form

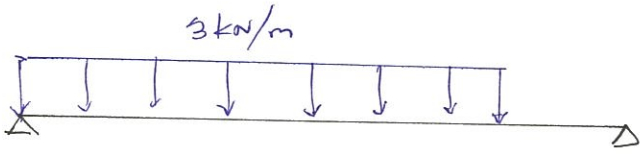
Live Load = $2\ kN/m^2 \times (1/2m) \times (2/3)^{\Delta factor}$

= $0.67\ kN/m$

Total Live Load Diagram

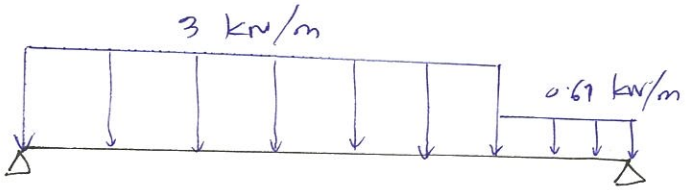


Slab A-B/2-4



Slab B-C/3-4

Total



Total Liveload A-B = 3 kN/m

Total Live load B-C = 0.67 kN/m

iv) Point Load from Beam B/2-4.

Point Load = R_4 at Beam B/2-4

= 37.59 kN

ULTIMATE LOAD FOR BEAM A-C/4

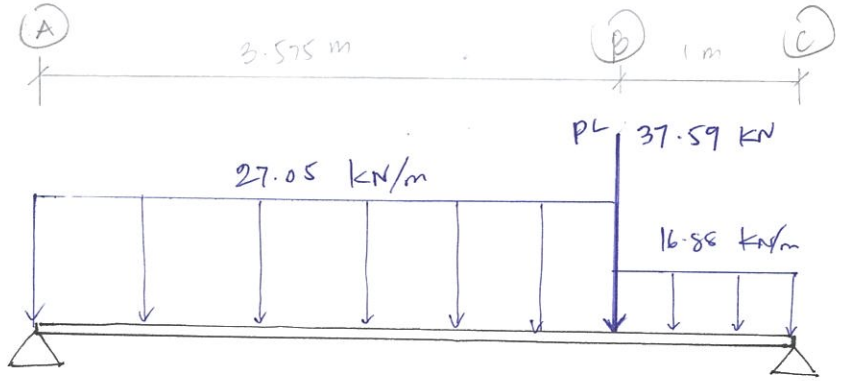
Apply factor 1.4 and 1.6 to dead load and live load respectively

* Dead Load A-B = 15.89 × 1.4 = 22.25 kN/m
* Dead Load B-C = 11.29 × 1.4 = 15.81 kN/m.

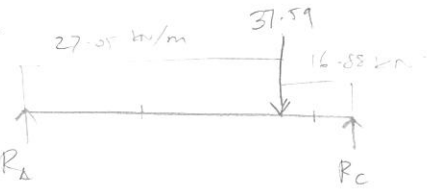
* Live Load A-B = 3 × 1.6 = 4.8 kN/m
* Live Load B-C = 0.67 × 1.6 = 1.07 kN/m

* Ultimate live load A-B = 22.25 + 4.8 = 27.05 kN/m
* Ultimate Load B-C = 15.81 + 1.07 = 16.88 kN/m

Ultimate Load Diagram



Reaction Forces for Beam A-C/4



$\Sigma M_A = 0$

$$\left[(27.05 \times 3.575) \times (3.575/2)\right] + (37.59 \times 3.575) + (16.88 \times 4.075) - 4.575 R_C = 0$$

$$4.575\, R_C = 172.86 + 134.38 + 68.79$$

$$R_C = 82.19 \text{ kN}$$

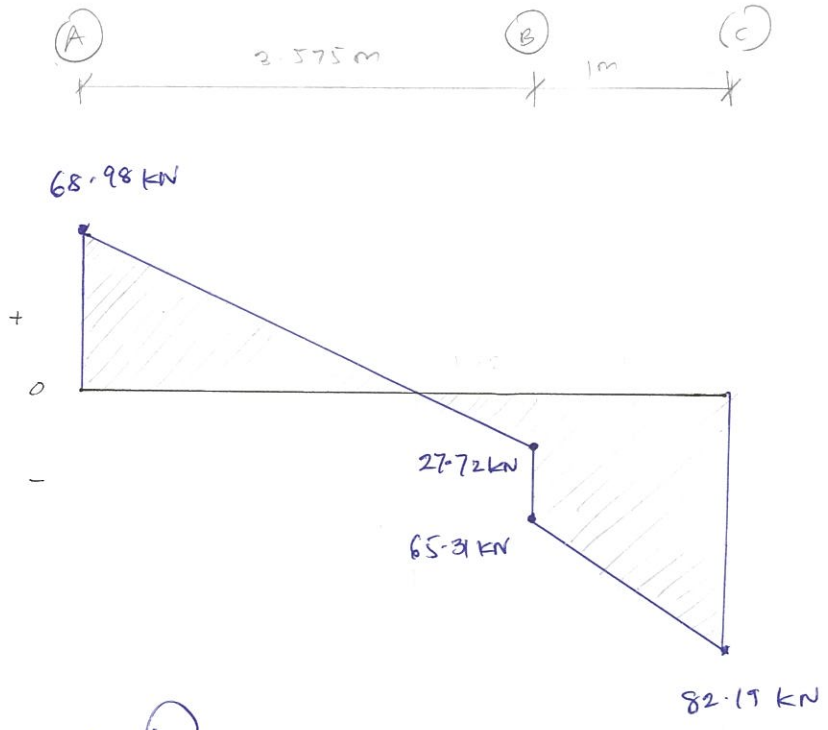
R_A = Total load - R_C

$= (27.05 \times 3.575) + 37.59 + 16.88 - R_C$

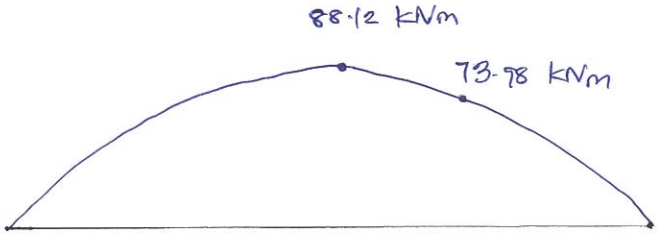
$= 151.17 - 82.19$

$R_A = 68.98$ kN

Shear Force Diagram



Bending Moment Diagram



⑤ First Floor Beam AC-2

i) Self weight of Beam → Deaid Load
ii) Brick wall → Dead Load
iii) Dead and Live Load from slabs ~~A-C/1-2, AB/2-4 and B-C/2-3~~
a) Dead Load from slab A-C/1-2, A-B/2-4 and B-C/2-3
b) Live load from slab A-C/1-2, A-B/2-4 and B-C/2-3
iv) Point Load from Beam B/2-4

---

i) Self Weight of Beam → Dead Load
= beam size x concrete density
= 0.15 x 0.3m x 24 kN/m³ = 1.08 kN/m

ii) Brick wall Weight → Dead Load
= wall height x width x brick density
= 3.3 x 0.15 x 19 = 9.41 kN/m.

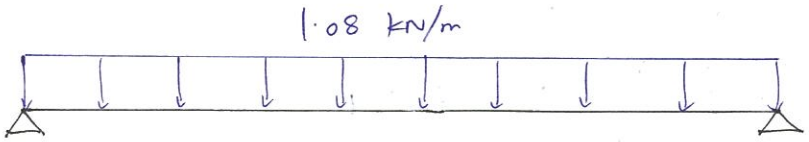
iii)a) Dead Load from Slab A-C/1-2 (2 way)
Load transfered in Trapezoidal form
Dedd Load = 3.6 kN/m² x (La/2)
= 3.6 x (4/2) = 7.2 kN/m

Dead Load from Slab A-B/2-4 (2 way)
Load Transfered in Trapezoidal form
Dead Load = 3.6 kN/m² x (La/2)
= 3.6 kN/m² x (3/2)
= 5.4 kN/m

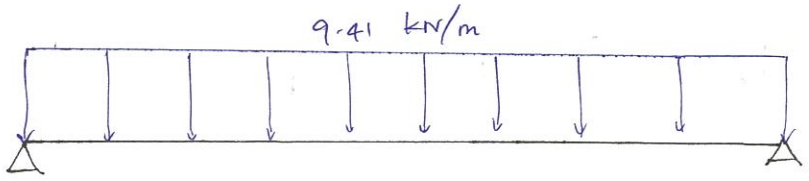
Dead Load from Slab B-C/2-3 (2 way)
Load Transfered in Triangular form
Dead Load = (2.4 kN/m² x (La/2) x (2/3) ← factor
= 2.4 kN/m² x 1/2 m x 2/3 = 0.8 kN/m

Total Dead Load Diagram

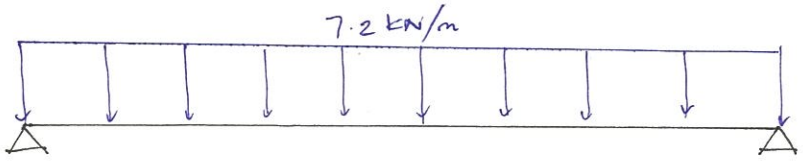
Beam self weight



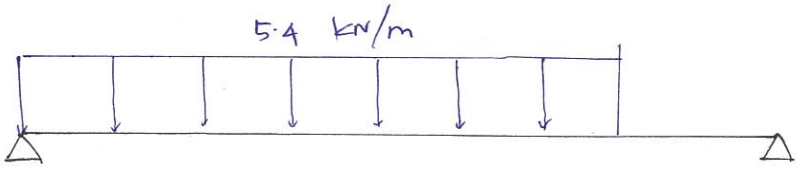
Brick wall weight



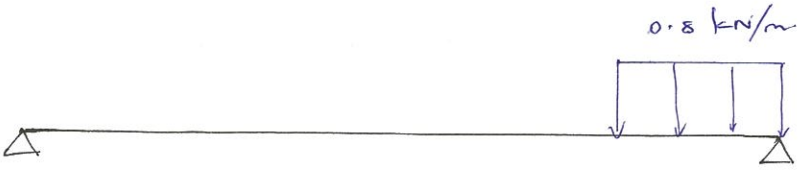
Slab A-C/1-2



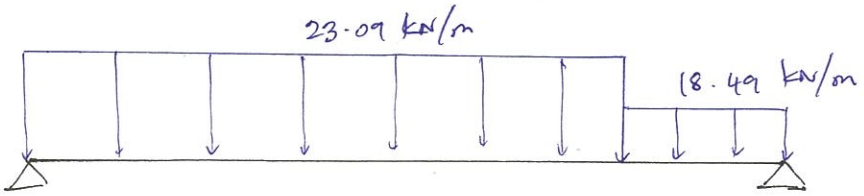
Slab A-B/2-4



Slab B-C/2-3



Total



Total Dead Load A-B = 1.08 + 9.41 + 7.2 + 5.4 =
= 23.09 kN/m

Total Dead Load B-C = 1.08 + 9.41 + 7.2 + 0.8
= 18.49 kN/m

iii) b) Live Load from Slab A-C/1-2 (two-way)

Load transfered in Trapezoidal form

Dead Load = 2.5 kN/m² × (Lx/2)
Live

= 2.5 kN/m² × (4/2m)

= 5 kN/m

- Live Load from Slab A-B/2-4 (two-way)

Load transfered in Trapezoidal form

Live Load = 2 kN/m² × (Lx/2)

= 2 kN/m² × (3/2 m)

= 3 kN/m

- Live Load from Slab B-C/2-3 (two way)

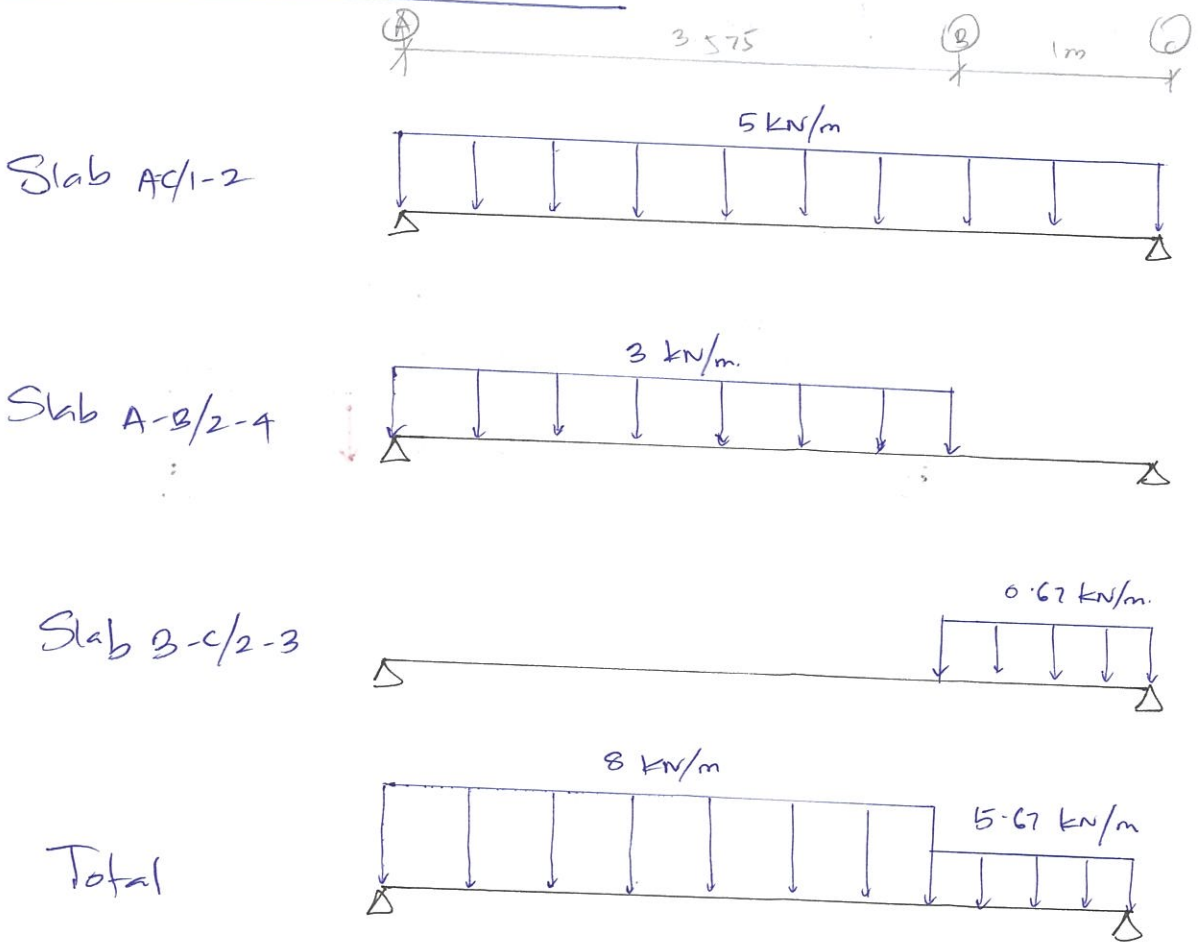
Load transfered in Triangular form

Live Load = 2 kN/m² × (Lx/2) × (2/3) ← factor

= 2 kN/m² × (1/2m) × 2/3

= 0.67 kN/m

Total Live Load Diagram



iv) Point Load from Beam B/2-4:

Point Load = R_2 at B/2-4

= 31.25 kN

ULTIMATE LOAD FOR BEAM A-C/2

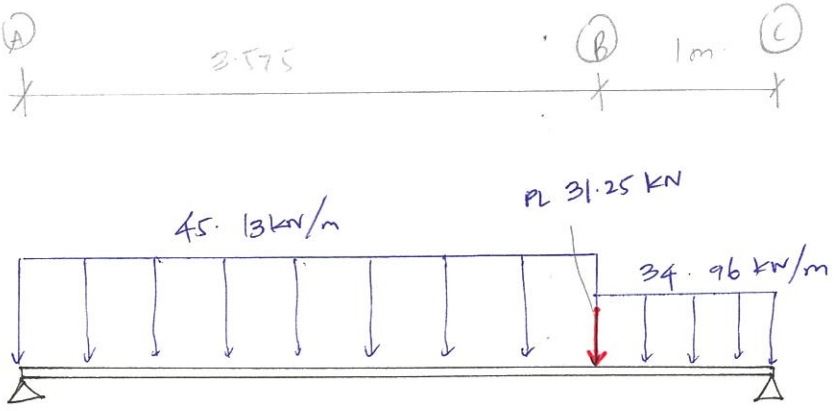
Apply factor 1.4 and 1.6 to dead load and Live load respectively

* Dead Load A-B = 23.09 × 1.4 = 32.33 kN/m
* Dead Load B-C = 18.49 × 1.4 = 25.89 kN/m

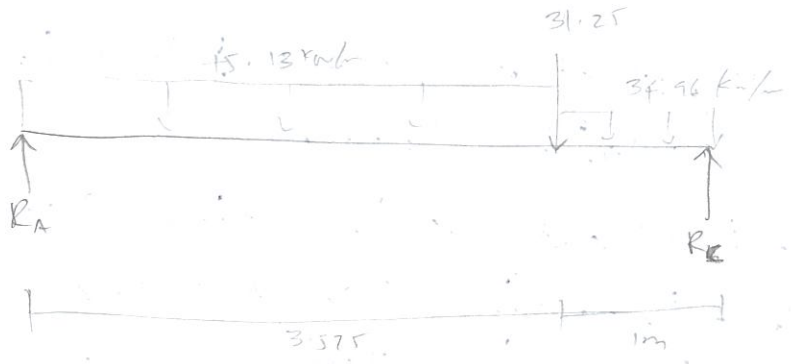
* Live Load A-B = 8 × 1.6 = 12.8 kN/m
* Live load B-C = 5.67 × 1.6 = 9.07 kN/m

* Ultimate Load A-B = 32.33 + 12.8 = 45.13 kN/m
* Ultimate Load B-C = 25.89 + 9.07 = 34.96 kN/m

Ultimate Load Diagram.



Reaction Forces for Beam A-C/2



$\Sigma M_A = 0$

$$\left[(45.13 \times 3.575) \times (3.575/2)\right] + (31.25 \times 3.575) + (34.96 \times 4.075) - 4.575 R_C = 0$$

$$4.575 R_C = 288.33 + 111.72 + 142.46$$

$$R_C = 118.58 \text{ kN}$$

R_A = Total Load - R_C

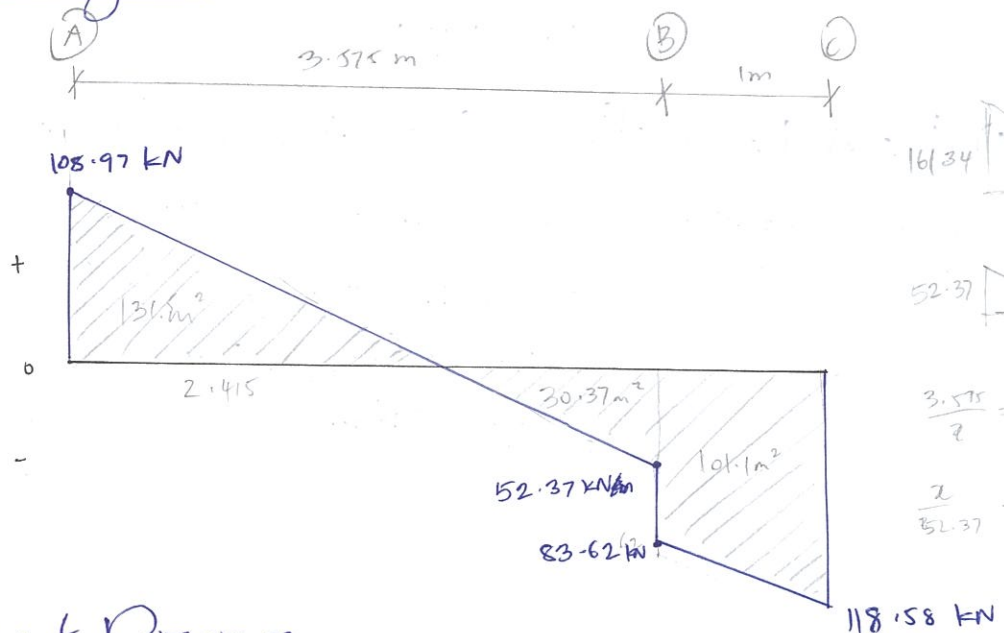
$= (45.13 \times 3.575) + 31.25 + 34.96 - 118.58$

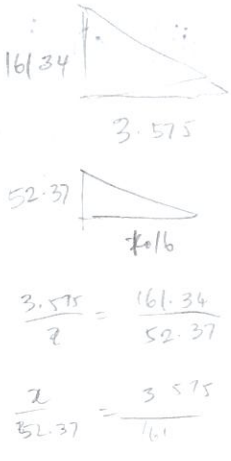
$= 227.55 - 118.58$

$R_A = 108.97$ kN

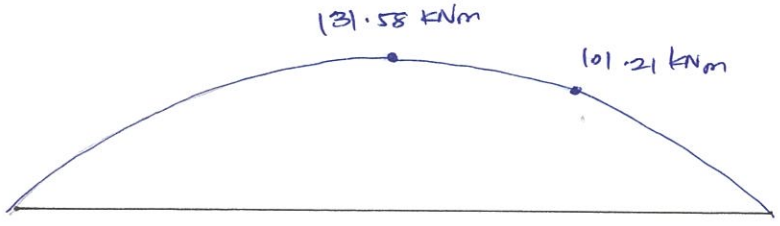
161.34

Shear Force Diagram





Bending Moment Diagram



⑥ First Floor Beam C/1-2

i) Self weight of Beam → Dead Load

ii) Brick Wall → Dead Load

iii) Dead Load and Live Load from Slabs

a) Dead Load from Slab A-C/1-2

b) Live Load from Slab A-C/1-2

---

i) Self weight of Beam → Dead Load

~~Load Transfered~~

Self weight = Beam size × concrete density

= 0.15×0.3×24 = 1.08 kN/m

ii) Brick wall weight → Dead load.

Brick Wall weight = Wall height × thickness × density

= 3.3×0.15×19

= 9.41 kN/m

iii) a) Dead Load from Slab A-C/1-2 (two-way)

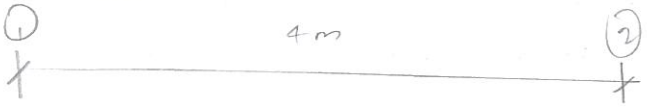
Load transfered in Triangular form ∆

Dead Load = 3.6 × $(L_2/2)$ × $(2/3)^{\Delta \text{ factor}}$

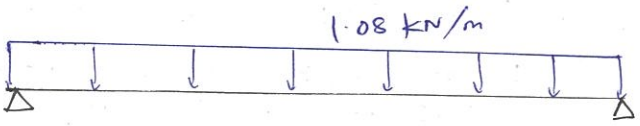
= 3.6 × (4/2) × 2/3

= 4.8 kN/m

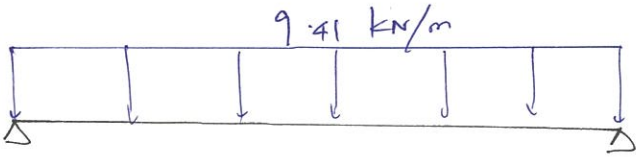
Total Dead Load Diagram



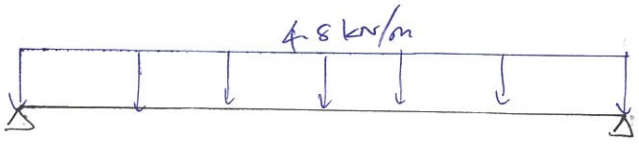
Self weight



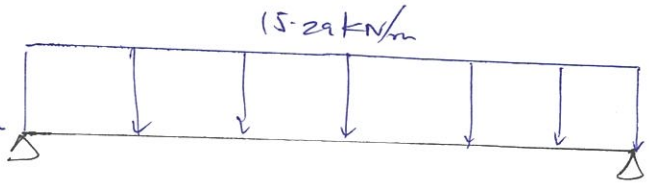
Brickwall weight



Slab A-C/1-2



Total = 15.29 kN/m



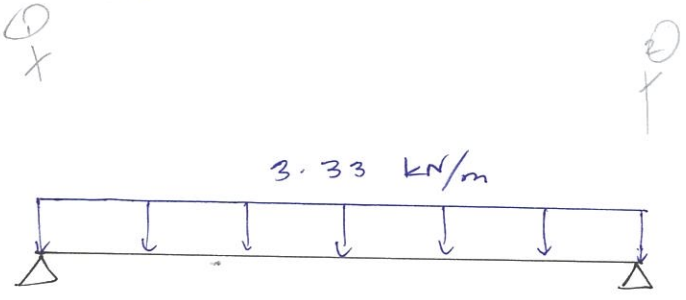
b) Live Load from Slab A-C/1-2 (2-way)

Load transfered in Triangular form

Live load = 2.5 kN/m² x (4/2) x (2/3) ← factor

= 3.33 kN/m

Total Live load Diagram

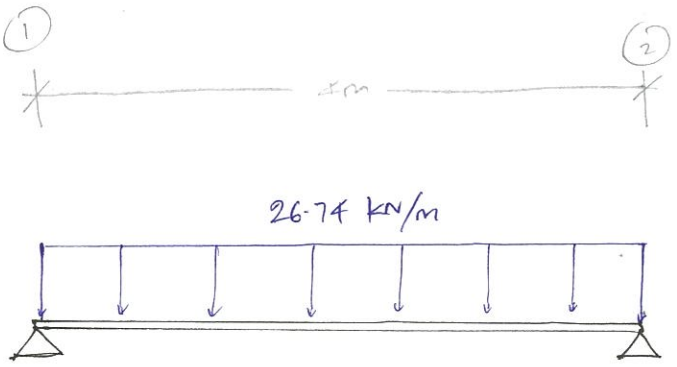


ULTIMATE LOAD FOR BEAM C/1-2

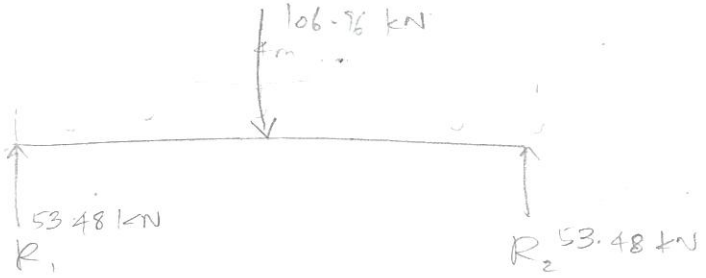
- Apply factor 1.4 and 1.6 to dead Load and Live load respectively

Dead Load 1-2 = 15.29 x 1.4 = 21.41 kN/m
Live Load 1-2 = 3.33 x 1.6 = 5.33 kN/m
Ultimate Load 1-2 = 26.74 kN/m

Ultimate Load Diagram for Beam C/1-2



Reactions Forces



$\Sigma M_1 = 0$

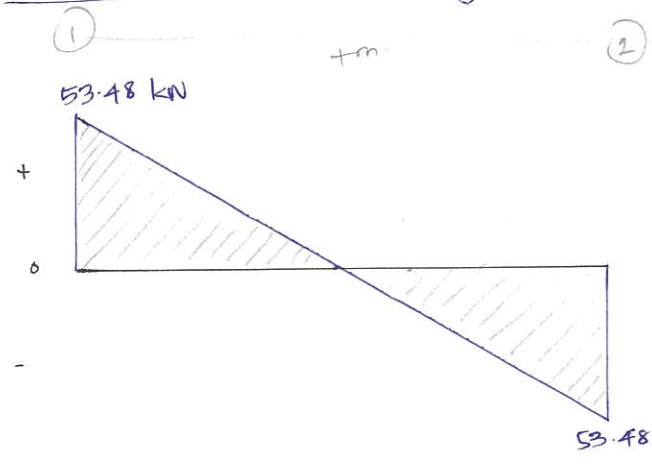
$[(26.74 \times 4) \times (4/2)] - 4R_2 = 0$

$4R_2 = 213.92$

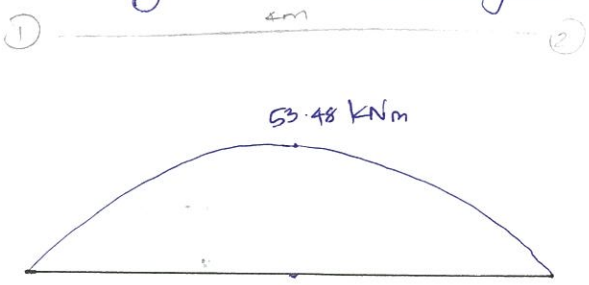
$R_2 = 53.48$ kN

R_1 = Total Load − R_2
= 106.96 − 53.48
R_1 = 53.48 kN

Shear Force Diagram



Bending Moment Diagram



COLUMN LOAD CALCULATIONS

① **Column A3** – Tributary Area Method.

i) Load from Ground floor (Gym)
   a) Dead Load
   b) Live load.

ii) Load from 1st Floor (Office)
   a) Dead Load
   b) live load

iii) Load from Roof Slab
   a) Dead Load
   b) Live load

---

i) Load from Ground floor (Gym)

a) Dead Load

* Slab Self weight = thickness x density
  = 0.15 x 24 = 3.6 kN/m²

Tributary Area = 1.5m x 2.28m = 3.43 m²

Dead Load = Area x weight
= 3.43 x 3.6
= 12.35 kN

* Beam Self weight = 1.08 kN/m

Dead load = Length x 1.08 kN/m
= (1.5 + 2.2875) x 1.08
= 4.1 kN

* Brick Wall weight = 10.26 kN/m

Dead load = length x 10.26 kN/m
= (1.5 + 2.2875) x 10.26
= 38.86 kN.

∴ Total dead Load from Ground floor = 12.35 + 4.1 + 38.86
= 55.31 kN

b) Live Load

Gym Live load = $4\ kN/m^2$

Live load = Area x $4\ kN/m^2$

= $3.43\ m^2 \times 4\ kN/m^2$

= $13.72\ kN$

ii) Load from first floor (office)

Total dead Load = total dead lab from Ground floor

a) Dead Load = $55.31\ kN$

b) Live Load

office Live load = $2\ kN/m^2$

Live load = Area x $2\ kN/m^2$

= 3.43×2

= $6.86\ kN$

iii) Load from Roof Slab

a) Dead load Slab self weight = $3.6\ kN/m^2$

* Dead load for slab = $3.6\ kN/m^2 \times$ Area

= 3.6×3.43

= $12.35\ kN$

* Beam Self weight = $1.08\ kN/m$

Dead load = $1.08 \times (1.5 + 2.875)$

= $4.1\ kN$

Total = $12.35 + 4.1 = 16.45$

~~Total~~

b) Live load

Live load for Roof = $0.5\ kN/m^2$

Lived Load = $0.5\ kN/m^2 \times$ Area

= 0.5×3.43

= $1.72\ kN$

Total Dead Load for Column A3 from Ground to Roof

$= 55.31 + 55.31 + 16.45$

$= \underline{127.07 \text{ KN}}$

Total Live Load for Column A3 from ground to Roof

$= 13.72 + 6.86 + 1.72$

$= \underline{22.3 \text{ KN}}$

- Ultimate Dead Load $= 127.07 \times 1.4 = 177.9$ KN
- Ultimate Live Load $= 22.3 \times 1.6 = 35.68$ KN.

Ultimate Load $= 177.9 + 35.68$

$= 213.58$ KN.

Determining Column Size

Assumptions

- $F_{cu} = 30 \text{ N/mm}^2$ (concrete strength)
- $F_y = 250 \text{ N/mm}^2$ (Yield strength of Steel)
- $AC = (150 \times 150) = 22500 \text{ mm}^2$ (Cross section Area)
- $A_{sc} = (22500) \times 2\% = 450 \text{ mm}^2$ (steel content in column)
- N = Concrete capacity)

$N = 0.4 f_{cu} Ac + 0.8 Asc Fy$

$= (0.4 \times 30 \times 22500) + (0.8 \times 450 \times 250)$

$= 270\,000 + 90\,000$

$= 360\,000 \text{ N} = \underline{\underline{360 \text{ KN}}} > 213.58 \text{ KN}$

~~Therefore Reduce Column size~~

~~Therefore column size 150mm x 150mm can support the ultimate load and can be reduce further to save material~~

Thus this column can sustain any load ultimate load below 360 KN > 213.58 KN

∴ Column size is suitable

(2) Column C2 — Tributary Area Method

i) Load from Ground floor (Gaming Room + Gym)
   a) Dead Load
   b) Live Load

ii) Load from 1st floor (Library + toilet + office)
   a) Dead Load
   b) Live load

iii) Load from Roof Slab
   a) Dead Load
   b) Live Load

---

i) Load from Ground floor (Gaming Room + Gym)

a) * Gaming Room Dead Load = $3.6\ kN/m^2$

Total Dead Load = $3.6\ kN/m^2 \times (2m \times 2.2875m)$
= $16.47\ kN$

Gym Room Dead Load = $3.6\ kN/m^2$

Total Dead Load = $3.6\ kN/m^2 \times (1.5 \times 2.2875m)$
= $12.35\ kN$

Total = $16.47 + 12.35 = 28.82\ kN$

* Beam selfweight = $1.08\ kN/m$

Dead Load = $1.08 \times (3.5 + 2.2875)$
= $5.79\ kN$

* Brick wall weight = $10.26\ kN/m$

Dead Load = $10.26\ kN/m\ (3.5 + 2.2875m)$
= $59.78\ kN$

Total dead Load for ground floor
= $28.82 + 5.79 + 59.78$
= $\underline{\underline{94.39\ kN}}$

b) Live Load (Gaming Room + Gym)

* Gaming Room live load = $2\ kN/m^2$

Live load = $2 \times (2 \times 2.2875)$

= $9.15\ kN$

* Gym Live Load = $4\ kN/m^2$

Live load = $4 \times (1.5 \times 2.2875)$

= $13.73\ kN$

Total = $9.15 + 13.73 = 22.88\ kN$

ii) Load From First Floor (Library + toilet + office)

a) Dead Load

* Dead Load for library = $3.6\ kN/m^2$

Dead Load = $3.6 \times (2 \times 2.2875)$

= $16.47\ kN$

* Dead Load for Toilet = $2.4\ kN/m^2$

Dead Load = $2.4 (1.5 \times 1)$

= $3.6\ kN$

* Dead Load for office = $3.6\ kN/m^2$

Dead Load = $3.6 \times (1.5 \times 1.2875)$

= $6.95\ kN$

Total = $16.47 + 3.6 + 6.95 =$ <u>$27.02\ kN$</u>

~~b) Live Load~~

* Beam selfweight = $1.08\ kN/m$

Dead load = $1.08 \times (3.5 + 2.5875 + 1 + 1.5)$

= ~~[illegible] kN~~ $8.95\ kN$

* Brick wall Weight = $10.26\ kN$

Dead Load = $10.26 \times (3.5 + 2.2875 + 1 + 0.5)$

= $74.77\ kN$

Total Dead Load from ~~Ground~~ First Floor

= $27.02 + 8.95 + 74.77$

= <u>$110.74\ kN$</u>

b) Live load (Library + Toilet + office)

* Live load Library = 2.5 kN/m²

Live load = 2.5 x (2x2.2875)
= 11.44 kN

* Live load for office = 2 kN/m²

Live Load = 2x(1.5x1.2875)
= 3.86 kN

* Live load for Toilet = 2 kN/m²

Live load = 2x(1.5x1)
= 3 kN

Total = 11.44 + 3.86 + 3
= 18.3 kN

iii) Load from Roof Slab

a) Dead Load

Slab Load = 3.6 kN/m²

* Dead Load = 3.6 x (3.5 x 2.2875)
= 28.82 kN

* Beam Solfweight = 1.08 kN/m

Load = 1.08 x (3.5 + 2.2875)
= 6.25 kN.

Total = 28.82 + 6.25 = 35.07 kN

b) Live load

Live load for Roof = 0.5 kN/m²

Load = 0.5 x (3.5 x 2.2875)
= 4 kN

Total Dead Load for C_2 from Ground to Roof

$= 94.39 + 110.74 + 35.07$

$= \underline{240.2\ kN}$

Total Live Load for C_2 from Ground to Roof

$= 22.88 + 18.3 + 4$

$= \underline{45.18\ kN}$

- Ultimate Dead Load $= 240.2 \times 1.4 = 336.28\ kN$
- Ultimate Live Load $= 45.18 \times 1.6 = 72.29\ kN$

Ultimate Load $= 408.57\ kN$

Determining Column Size

150 x 150 column can support an ultimate Load of 360 kN only $\quad 360 < 408.57$

∴ Column size needs to be increased

New Column Size (150x175)

$N = 0.4\, f_{cu}\, A_c + 0.8\, A_{sc}\, F_y$

$= (0.4 \times 30 \times 150 \times 175) + (0.8 \times 525 \times 250)$

$N = 420\,000 = 420\ kN$

Thus new column size (150 x 175) can support the ultimate Load $408.57 < 420$

∴ New suitable column size is 150mm x 175 mm

(3) Column C3 → Tributary Area Method

i) Load from Ground Floor (Gym)
   a) Dead Load
   b) Live load

ii) Load from 1st floor (office + Toilet)
   a) Dead Load
   b) Live load

iii) Roof slab Load
   a) Dead Load
   b) Live load

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i) Load from Ground Floor (Gym)

a) Dead Load:

* Gym Room Dead Load = $3.6\ kN/m^2$

  Dead Load = $3.6 \times (1.5 \times 2.2875)$

  = 12.35 kN

* Beam Load = 1.08 kN/m

  Dead Load = $1.08 \times (1.5 + 2.2875)$

  = 4.1 kN

* Brick wall Load = 10.26 kN/m

  Dead Load = $10.26 \times (1.5 + 2.2875)$

  = 38.86 kN

Total Dead Load from Ground Floor

= 12.35 + 4.1 + 38.86

= 55.31 kN

b) Live Load (Gym)

Gym Live load = 4 kN/m²

Live load = 4 × (1.5 × 2.2875)

= 13.73 kN

ii) Load From First Floor (Office + Toilet)

a) ~~Dead Load for office and Toilet = 2 kN/m~~

* Dead Load for office = 3.6 kN/m²

Dead Load = 3.6 × (1.5 × 1.2875)

= 6.95 kN

* Dead Load for Toilet = 2.4 kN/m²

Dead Load = 2.4 (1.5 × 1)

= 3.6 kN

* Beam Self weight = 1.08 kN/m

Dead Load = 1.08 × (3 + 2.2875)

= 5.71 kN

* Brick wall weight = 10.26 kN/m

Dead Load = 10.26 × (3 + 2.2875)

= 54.25 kN

Total Dead load from 1st Floor

= 6.95 + 3.6 + 5.71 + 54.25

= 70.51 kN

b) Live load

Live load for toilet and office = 2 kN/m²

∴ Live load = 2 × (1.5 × 2.2875)

= 6.86 kN.

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iii) Load from floor Slab.

a) Dead Load

* Slab load = 3.6 kN/m²

Dead Load = 3.6 × (1.5 × 2.2875)

= 12.35 kN.

* Beam Self weight = 1.08 kN/m

Dead Load = 1.08 × (1.5 + 2.2875)

= 4.1 kN

Total = 12.35 + 4.1 = 16.45 kN

b) Live Load

Live load for Roof slab = 0.5 kN/m²

Load = 0.5 × (1.5 × 2.2875)

= 1.72 kN

Total Dead load for C3 from Ground to Roof

$= 55.31 + 70.51 + 16.45$

$= \underline{142.27 \text{ KN}}$

Total Live load for C3 from Ground to Roof

$= 13.73 + 6.86 + 1.72$

$= \underline{22.31 \text{ KN}}$

- Ultimate Dead Load $= 142.27 \times 1.4 = 199.18$ KN
- Ultimate Live Load $= 22.31 \times 1.6 = 35.7$ KN

$$\underline{\text{Ultimate Load} = 234.88 \text{ KN}}$$

Determining Column Size

* 150 x 150 mm column can support an ultimate load of 360 KN

Thus column C3 can sustain any Ultimate Load below 360 KN $>$ 234.88 KN.

$\therefore$ Column C3 is strong enough