85 Camden Mews
London   NW1 9BU

Design of Basement

DETERMINATION OF LOADING ON NEW BASEMENT WALLS

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Job 512
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NOTES ON THE DESIGN

The existing two storey (ground floor and first floor) house is to be extended to the rear and a basement installed over the complete plan area of the house.

These calculations cover the determination of the loads acting on the reinforced concrete basement construction. It is assumed the basement will need to support the construction of the house above (no 85) and the take loads from the adjacent houses (nos 83 and 87) where their direct vertical loads are considered as a surcharge load to become lateral horizontal load. This is in addition to the active soil pressures, although there are plans to create a basement to at least no 85 in the near future.

The sizes of the key structural elements are also considered.

Calculations are to read in conjunction with architectural drawings.

DESIGN CODES

Building Regulations Part A
BS 449: Structural Use of Steelwork
BS 648: Weights of Building Materials
BS 6399 Part 1: Design Loading for Buildings
BS 8102: CP for Structures against water from the Ground.
Institution of Civil Engineers CP. Earth Retaining structues.
BS1100; Structural Use of Reinforced Concrete.

SOIL CONDITIONS

Information provided by Southern Testing's Report:
Basement Impact Assessment: Screening/ Scoping Report. Project Ref: J11954.

Bearing soil: London Clay.
Bulk Density of soil: 20 kN/ m2
Undrained Shear Strength (Temp. condition) = 60- 120 KN/ m2
Long term Drained Condition: theta - 25 degrees.
Inst. of Civil Engineer's CP2, table 5, Ka= 0.30- 0.42.

Swelling and Shrinkage: Plasticity Index (PI) = greater than 40%. Falls within the NHBC High Volume Change Classification.

MATERIALS DATA

<u>Reinforced Concrete to Basement Slab and Retaining Walls</u>

Grade RC40
Max free water /cement ratio: 0.55.
Min cement content: 325kg/m3

<u>Reinforced Concrete to ground floor slab</u>
Grade RC35
Max free water /cement ratio: 0.60.
Min cement content: 300kg/m3

<u>New Blockwork</u>
Dense concrete blocks laid in 1:1:6 mortar. Basic Compressive stress: 7.0 N/mm2.
That design stress as 0.70 N/mm2.

<u>Structural Timber to floor</u>
Bending para // grain: 7.5 N/m2
E min: 7,200/mm2
E mean: 10,800 N/mm2

FIRE RATING

It is assumed that there is no requirement for structural elements to be fire resisting.

WIND LOADING

It is a modest structure on the edge of the city. No additional measures are to be taken other than installing strapping in line with good building practice.

LOADING: SELF WEIGHT

<u>Pitched roof re-roofed</u>		
Slates on battens with insulation	0.55 kN/ m2	
Sw roof joists	0.09 kN/ m2	
Plasterboard lining	0.13 kN/ m2	
Ceiling joists	0.09 kN/ m2	
Plasterboard soffit	0.13 kN/m2	1.00 kN/ m2
<u>First Floor</u>		
Floor boards on	0.09 kN/m2	
Floor joists	0.09 kN/m2	
Plasterboard ceiling	0.13 kN/m2	0.35 Kn/ m2
<u>Ground Floor</u>		
Floor boards on	0.09 kN/m2	
Insulation and heating piping	0.04 kN/m2	
200mm thick rc slab	4.80 kN/m2	
Plaster skim	0.05 kN/m2	5.00 kN/ m2
<u>Front and Rear External walls</u>		
105mm external brickwork	2.25 kN/m2	
Cavity insulation	0.02 kN/m2	
100mm concrete blockwork	4.80 kN/m2	
Plaster finish	0.05 kN/m2	5.00 kN/ m2
<u>Front and Rear External walls</u>		
105mm external brickwork	2.25 kN/m2	
Cavity insulation	0.02 kN/m2	
100mm concrete blockwork	1.20 kN/m2	
Plaster finish	0.13 kN/m2	3.35 kN/ m2
<u>Internal walls</u>		
Sw studs	0.10 kN/m2	
Plasterboard + skim	0.30 kN/m2	0.40 kN/ m2
<u>Basement walls</u>		
400mm RC	9.6 kN/m2	
Cavity insulation +waterproofing +studs	1.00 kN/m2	
Plaster finish	0.15 kN/m2	10.75 kN/ m2
Light Well Walls	6.00 kN/m2	
300mm RC	1.15 kN/m2	7.15 kN/ m2

LOADING: IMPOSED

<u>Roof load</u>	
UDL	0.60 kN/m2
Attic storage	0.25 kN/m2
General floor loading	1.50 kN/m2
Surcharge from vehicles on front basement wall	10.00 kN/m2

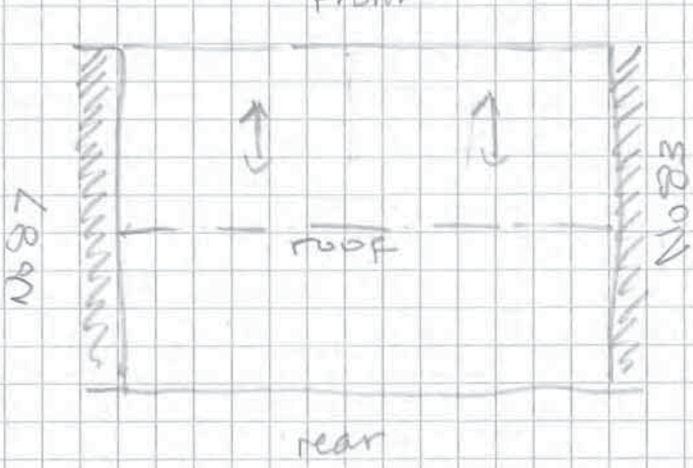
LOADING: WIND

The proposed building is a traditional low rise built in a protective location. In addition the building is of inherently robust construction. Wind loading may be ignored.

(A) DETERMINATION OF TOAL LOAD FROM No 85 onto BASEMENT WALLS

Loading from Roof and attic on enclosing external walls

- Consider Roof + attic



Total load from roof and attic

$= 9.50m \times 7.9m \times 1.00 kN/m^2$

$= 75 kN \downarrow$ over $77 m^2$ plan.

for simplicity, suppose the load is shared to the enclosing walls

Load / wall = $\underline{19 kN} \downarrow$ over $77 m^2$ plan.

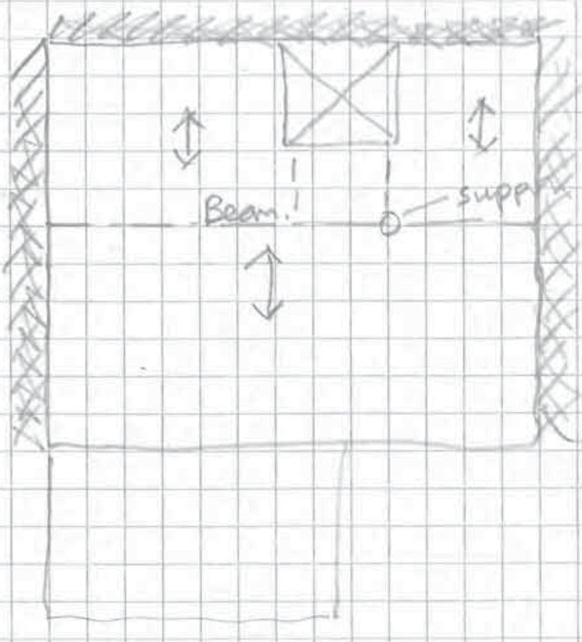
Live loads (total): $9.50 \times 7.9 \times (0.60 + 0.15) kN/m^2$

$= 56 kN$.

again suppose load shared on 4 No enclosing walls

LL on wall = $\underline{56 kN} \div 4 = \underline{14 kN \downarrow}$

- Consider 1st floor



Total load from first floor

$= 9.5 \times 7.9m \times 0.35 kN/m^2$

DL = $26 kN \downarrow$

for simplicity suppose load is shared equally to 4 No basement walls

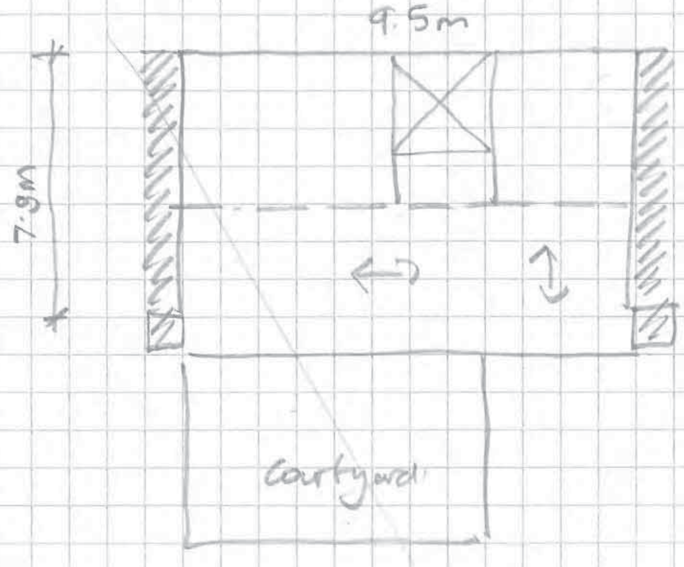
Load, DL = $26/4 = \underline{6.5 kN} \downarrow$

Total DL $= 9.50 \times 7.90 \times 1.50 kN/m^2 = 112 kN \downarrow$

Again, suppose load is shared by 4 enclosing basement walls

load/wall (DL) $= 112 kN/4 = \underline{28 kN} \downarrow$

Loading from ground floor onto enclosing walls



Total load from ground floor

$= 9.50m \times 7.90m \times 5.00\ kN/m^2$

$= 375kN \downarrow$

for simplicity, suppose the load is shared on the enclosing walls

Load/wall $\simeq$ 94 kN $\downarrow$

Total Live load:

$= 9.50 \times 7.90 \times 1.50\ kN/m^2 = 112\ kN$

Load / wall $= 112/4 = 28\ kN \downarrow$

90
319.5
409.5

Load from internal partitions

2 No floors. (grd + 1st floor)

$= 2No. \times 20m$ lin. length $\times 0.4\ kN/m^2$

$= 40\ kN$ total $\downarrow$

Say load load/wall $= 40 \div 4 = 10kN \downarrow$

Determination of external walls

- Front External wall: $5m \times 9m \times 3.35\ kN/m^2 \times$ (window allowance) $\times 80\%$ $= 120\ kN \downarrow$

- Rear External wall: area: $9m \times 5m = 45m^2$
  minus grd floor opening: $4.6 \times 2.4m^2 = 11m^2$
  Loading area $= 45m^2 - 11m^2 = 34m^2$
  taking allowance for $34m^2 \times 3.35m^2 \times 0.8$ $= 90kN \downarrow$ total

- party wall No 87/85: $7.5m(av) \times 7.9m \times 3.35\ kN/m^2 =$ $200kN \downarrow$

- party wall No 83/83: as above $200kN \downarrow$

Determination of Loading on party wall to No 85 from loading to New/rebuilt No 85.

	DL	LL
Total load from the construction of No 83. (See Schedule 1)	518 kN	280 kN

plan area of No 83 = 9.50 × 7.90 m = 75 m²

$DL/m^2 = 518/75m^2 = 7\ kN/m^2$

$LL/m^2 = 280/75m^2 = 3.7\ kN/m^2$

The plan area of No 83 = 3m × 6m say = 18 m²

Total load on 83 = $7\ kN/m^2 \times 18m^2 = 126\ kN \downarrow$ (DL)

and $3.7\ kN/m^2 \times \cancel{1}8\ m^2 = 67\ kN \downarrow$ (LL)

total Loading on No 85 : (DL) = ↓ 518 kN

(LL) = ↓ 280 kN

Ratio of Load on No 83 compared to on No 85

$$DL = \frac{126}{518} = 0.25 \text{ ratio}$$

$$LL = \frac{28.0}{280} = 0.10 \text{ ratio.}$$

Load on party wall No 83/85.

total loads
126 kN ↓
+
67 kN ↓

LL

Load ratio (DL) = 1/4 × (Load from each element) W_{83}

× 0.25 =

= 0.06 × W83

No 87 No 85

Load ratio = $\frac{1}{4}$ × Load from each element, W83 × 0.10

= 0.003

		DL	LL
So load on 83/85 party wall:			
Roof + attic: 76 × 0.06 DL	7kN	5.6 kN	
56 × 0.083 LL			0.8 kN
First floor 26 × 0.06 DL	3kN	1.6 kN	
112 × 0.003			1.6 kN
Ground floor 376 × 0.06	3kN	2.3 kN	
112 × 0.003			0.3 kN

internal walls ignore

SW rebuilt party wall (p6) = 200kN

total loads from No87 to No85 = 13kN ↓ (DL + LL)

Note that there is a degree of (double accounting) for the ground floor

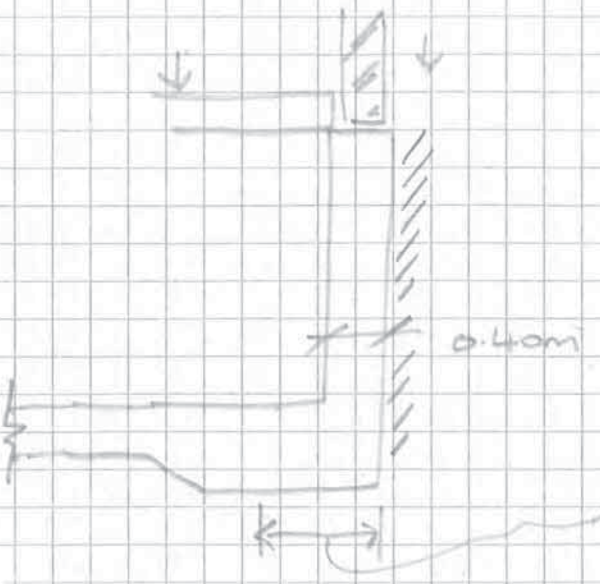
In addition there is a vertical load to be converted into lateral load through the active pressure of soil.

Our approach may be considered to be a little conservative.

DIRECT LOAD ON PARTY WALLS.

Consider direct loading on basement walls - party walls

Look at basement wall to party walls 83 (87 similar)



↓ (sch. No1)
DL + LL = 1 = 335

42x
SW basement walls: = 42 KN

2.8 KN / m run x 42
10.75 KN/m x 10.75 = 205.8 KN

min bearing 0.75m ↓ 683.8 KN

Direction load

Bearing pressure = Basement wall: 10.5 KN

704.3 KN

$$\frac{704.3\ kN}{12.5\ m} = 70 kN/m^2$$

Consider Rear external wall.

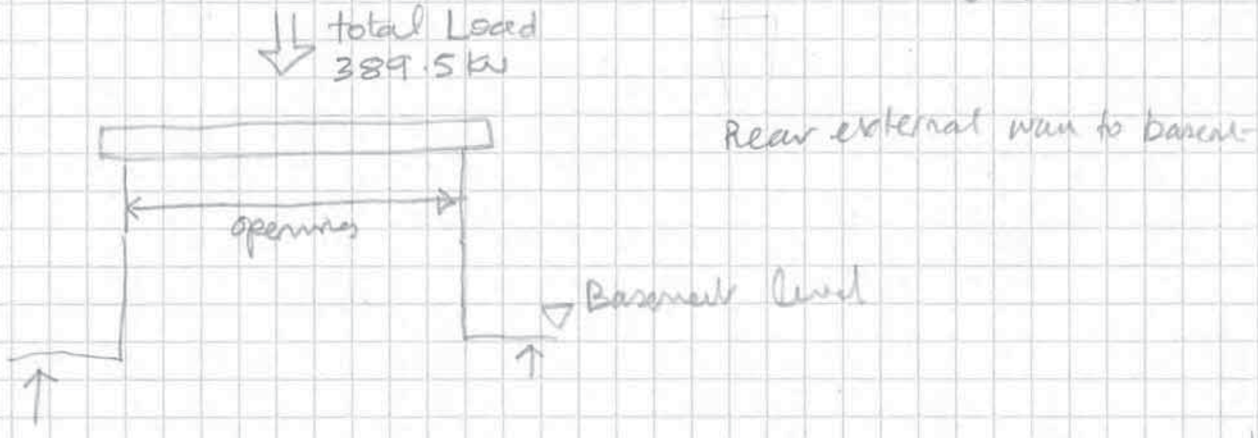
total
Load at ground floor level. (DL + DL) = 389.5 kN
(see sch. 1)

Load from Basement wall ~~*~~ basement-grd =

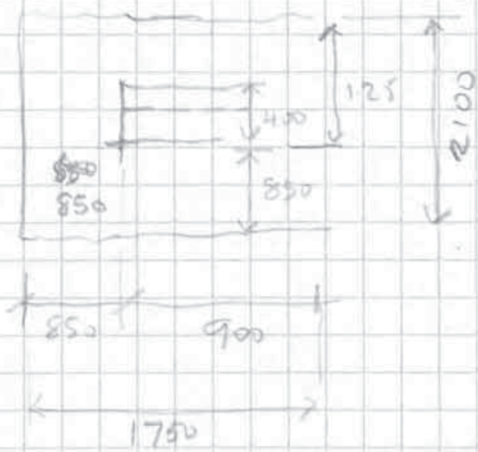
area = 0.6 × 2.4 + 0.9 × 2.4
= 1.44 + 2.16 = 3.6 m²

3.6 m² × 9.5 = 34 kN

424 kN



reaction at basement level = 389.5/2 + 34/2 = 212 kN



125
− 40
85

Bearing on ground = $\frac{212 \text{ kN}}{1.750 \times 2.100}$ = 57 kN/m²

Total surcharge on party wall No 85/83

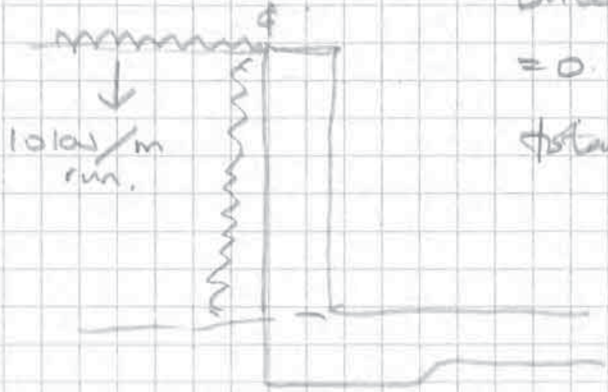
Ref to p. 8) Total Load DL + LL = 13 KN ↓
over 6m, say of the party wall

= 13 KN total ÷ 6m = 2.2 KN / m run.

Consider surcharge of vehicle loading to front basement wall:

10 KN / m². total Load = 9.7m × 10 = 97 KN ↓

Line Load = 97 KN ÷ 9.7 = 10 KN / m run



Line Load (horizontal)

= 0.40 (factor) × 10 KN/m run = 4 KN,

total → surcharge on back of wall

= 4 KN × 2.4m
= 10 KN →

Consider surcharge of vehicle loading to side party wall: total load = 2.2 KN/m run.

As surcharge on basement walls is most onerous from vehicle loading on the front wall, it is proposed to use this loading in determining the lateral resistance of the wall.

* Design walls to take 2.2 KN / m lateral line load

Design of basement walls as vertical cantilevers.

Consider Front basement wall: = total active pressure = 0.4

soil pressure = $K_a \times Z \times \gamma$

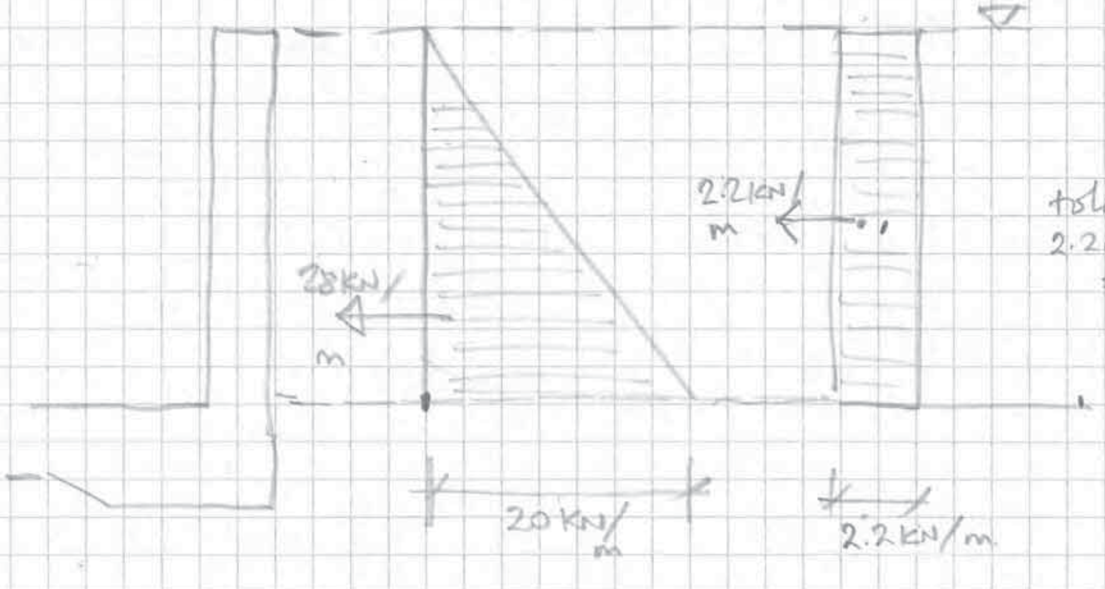
at base = 0.40 say $\times$ 2.8m $\times$ 18 KN/m³ = 20 kN.

consider surcharge 10KN/m²

~~equivalent wt in soil =~~

~~load a~~

Total surcharge = 0.4 (Ka) × 10N/m² = 4 kN/m³



total soil load on wall = ½ × 20KN × 2.8m = 28 KN (total)

total surcharge load on wall = 2.2m × 2.8 KN = 11 KN (total)

Σ Horizontal loads = 28 kN + 11 kN = 39 kN
(working)

Σ Hor. loads (factored)

$= \underset{kN}{28} \times 1.4 + \underset{kN}{6} \times 1.6 = 39.2 + 15.4 = 55$ kN
(total)
(factored)

Shear on wall per m run $= \dfrac{55\,kN}{9.7\,m \times 0.330\,m}$ 17 N/mm²

✓ OK low

Take moments about 'b' (factored)

$1.4 \times \underset{kN}{28\,kN} \times 0.93 + 1.6 \times 6\,kN \times 1.4\,m$

$= 36.5 + 13.4$ kN m $= 50$ kN m

$M/bd = \dfrac{50\,kN\,m \times 10^6}{1000 \times (330)^2} = 0.46$

(Ref. to BS 8110

$100A_s/bd = 0.10$

$A_s = \dfrac{0.10 \times 10^3 \times 330}{1000} = 330\,mm^2$ per m linear run

BS 8110, table 3.2 $\dfrac{M}{bd}$

(min. reinft $= 0.46/0.33 \times 1.0 = 139\,mm^2$ per m lin. run

Use T16 bars @ 200 mm crs = 643 mm²/m

~~T16 @ 225 crs = 723~~
~~T16 @ 250 crs = 804~~

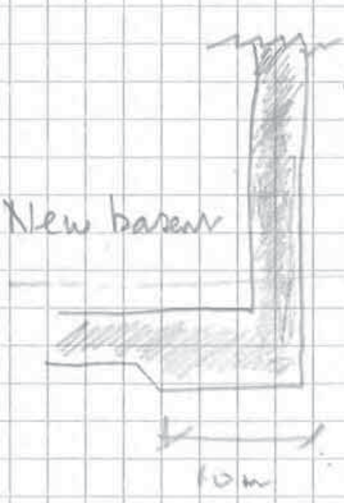
~~$\dfrac{0.99 \times 10^6}{1000 \times 330} = 0.30$~~

provide T16 @ 200 mm crs = 1010 mm²/m run

DESIGN OF BASEMENT WALLS TO LIGHTWELL

Total load on ground. /m run

$= 0.3 \times 2.8m \times 0.10$ (cavity) + plaster $= 6.0\ kN/m^2$

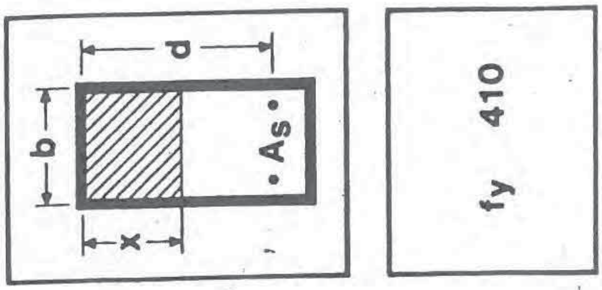


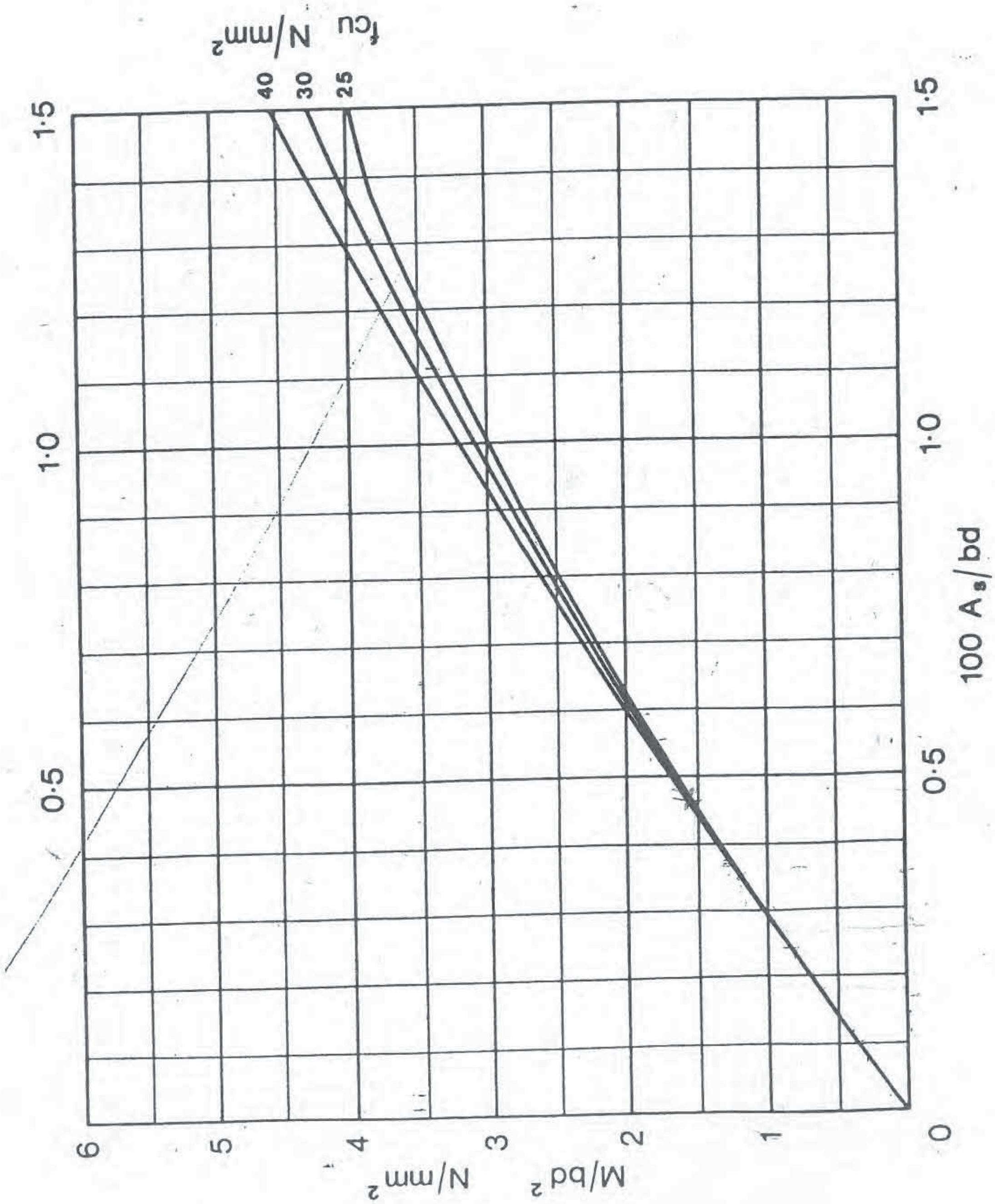
Load = 6.0 kN/m

Load on basement mat $\frac{60\ kN}{10} = 60\ kN/m^2$

✓ OK for basement slab

APPENDIX 'A'





Singly reinforced be(ms

LOADING ON BASEMENT WALLS									
LOADS APPLIED TO TOPS OF ENCLOSING WALLS AT GROUND FLOOR LEVEL.									
	Front External wall		**Rear External Wall**		**no 83 Party Wall**		**no 87 Party Wall**		**totals**
	Total Direct Load		**Total Direct Load**		**total Direct Load**		**Total Direct Load**		
	DL	~~LL~~	DL	LL	DL	LL	DL	LL	
Roof and attic:DL	19		19		19		19		**76**
Roof and attic: LL		14		14		14		14	**56**
Roof and attic: allowance for DL+ LL-adj. properties	0	0	0	0	3	2	3	2	
			0						
First floor: DL	6.5	0	6.5	0	6.5		6.5		**26**
First floor: LL	0	28		28		28		28	**112**
First floor: allowance for DL+LL-adj. properties	0	0	0	0	3	2	3	2	**10**
			0						
Ground Floor: DL	94	0	94	0	94		94		**376**
Ground Floor: LL	0	28		28		28		28	**112**
Ground Floor: Allowance for DL + LL-adj properties	0	0	0	0					**10**
			0						
Internal Wall construction	10		10		10		10		**40**
External walls: grd- roof	120		90		200		200		**610**
Total loads DL and LL	**249.5**	**70**	**319.5**	**70**	**335.5**	**74**	**335.5**	74	**1428**
Combined Total loads_ DL + LL	**total ~~199.5kN~~**		**total 389.5 KN**		**total 409.5 KN**			**total 409.5kN**	

NOTES
Loads shown are very approximate
Loads are working, unfactored loads and assumes good distribution loading through the structural elements