LONGSIGHT DESIGN CONSULTANCY

CONSULTING CIVIL & STRUCTURAL ENGINEERS

CALCULATIONS RELATING TO

DESIGN OF STEEL BEAMS TO SUPPORT FIRST FLOOR

AT

110 HUDDERSFIELD ROAD, WILLTHORPE, BARNSLEY

CONTENTS

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03	Design of Beam 1
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14	Sketch layout plan

References

- BS5628 Part 1
- BS5950 Part 1
- BS6399 Part 1
- Constrado Steelwork Handbook Volume 1
- Architects drawing
- TEDDS Simple Beam Designer

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PROJECT		REF
ELEMENT	CALCS BY.	DATE
	CHECKED	DATE

REF	CALCULATIONS	OUTPUT

Loads

Roof (d)

Tiles + felt + battens	= 0.65 Kn/m²
Rafters	= 0.15 "
Insulation	= 0.10 "
Ceiling	= 0.25 "
	= 1.15 Kn/m²

On plan = $\frac{1.15}{\cos 36^\circ}$ = 1.42 Kn/m² *

Roof (i)

Imposed loading = 0.60 Kn/m² *

Attic Floor (d)

Floorboards	= 0.20 Kn/m²
Joists (floor)	= 0.20 "
Joists (ceiling)	= 0.10 "
Insulation	= 0.05 "
Plasterboard + skim	= 0.25 "
	= 0.80 Kn/m² *

First Floor (d)

Floorboards	= 0.20 Kn/m²
Joists	= 0.15 "
Plasterboard + skim	= 0.25 "
	= 0.60 Kn/m² *

Attic + First Floor (i)

Imposed loading = 1.50 Kn/m² *

SHEET NO: 01

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	Internal wall (d)	
	100mm brick = 2.20 Kn/m² 2 coats of plaster = 0.40	
	= 2.600 Kn/m²	*
	Studwork (d)	
	Timber studding = 0.50 Kn/m²	*

SHEET NO: 02

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CALCULATIONS

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Beam 2

Span = 2.0m

Loading

Wall (d) = 2.6 × 2.7 = 7.02 × 1.4 = 9.83

$BM_{max} = \frac{9.83 \times 2.0^2}{8} = 4.92$ Kn m

$SF_{max} = \frac{9.83 \times 2.0}{2} = 9.83$ Kn

Le = 1.2L = 2.5m

Try a 178×102×18 UB $M_b = 29.1$ Kn m

Check deflection

$\delta_{act} = \frac{5 \times 7.02 \times 2000^4}{384 \times 205 \times 10^3 \times 1356 \times 10^4} = 1.0$mm

$\delta_{allow} = 4/360 = 5$mm > 1.0mm OK

Check bearing

Allowable stress a Beam 1 = 1.43 N/mm²

Padstone size reqd = $\frac{9.83 \times 10^3}{100 \times 1.43} = 70$mm

∴ Adopt 440mm lg × 100mm wide × 215mm dp C30 Concrete padstone.

∴ Adopt 178×102×18 UB (S275)

SHEET NO: 03

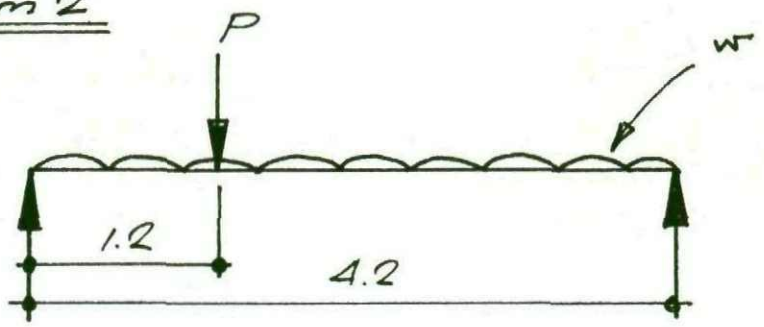
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CALCULATIONS

REF | OUTPUT

Beam 2



Loads

W (dead)

Loading from attic floor is taken as a Point load spread over length of beam

Roof(d) = 1.42 x 4.2 x 0.5 x 6.5 x 0.5 = 9.70
Stud(d) = 0.50 x 0.70 x 6.5 x 0.5 = 1.14
Attic(d) = 0.80 x 6.2 x 0.5 x 6.5 x 0.5 = 8.06

= 18.90

UDL = 18.90/4.2 = 4.5 Kn/m

∴ UDL on Beam

UDL From Attic = 4.50 Kn/m
First (d) = 0.60 x 6.5 x 0.5 = 1.95 "
Wall (d) = 2.60 x 2.7 = 7.02 "

= 13.47 Kn/m *

W (Imposed)

Roof (i) = 0.60 x 4.2 x 0.5 x 6.5 x 0.5/4.2 = 0.975 Kn/m
Attic(i) = 1.50 x 6.2 x 0.5 x 6.5 x 0.5/4.2 = 3.600 "
4.575
First (i) = 1.50 x 6.5 x 0.5 = 4.88

= 9.45 Kn/m *

P(dead)

Reaction from beam 1 = 7.02 x 2/2 = 7.02 Kn *

SHEET NO: 04

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Check bearing

Allowable stress $= \frac{1.25\, f_k}{\gamma_m}$

f_k for 4 N/mm² blocks = 4.0

$\gamma_m = 3.5$

$\therefore$ Stress $= \frac{1.25 \times 4}{3.5} = 1.43\ N/mm^2$

Length of padstone reqd.

$\frac{1980 \times 10^3}{100 \times 1.43} = 558$ mm $\therefore$

$\therefore$ Adopt a 675 mm lg x 100 mm wide x 215 mm dp C30 Concrete padstone

$\therefore$ Adopt 305x127x48UB (S275)

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Project : Alterations at Ground Floor Level

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File : LDC08-015-Beam 2

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Beam Summary Table:

Reference	Span [m]	Section Size, Grade
Beam 2	4.200	UB 305x127x48 S275

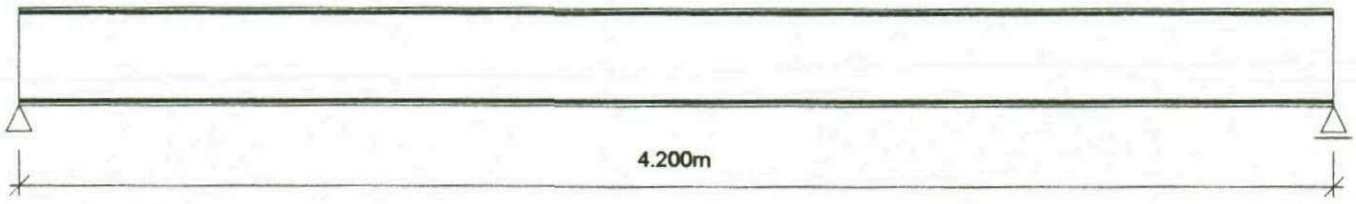
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REFERENCE: Beam 2



UB 305x127x48
S275

Beam

UB 305x127x48 S275
Span, L 4.200 m

Restraints

Left hand support type 3 Compression flange laterally restrained.
Both flanges free to rotate on plan.
Beam fully restrained against torsion.

Start position [m]	End position [m]	Sub-beam length [m]	Normal eff. length -	Destab. eff. length -
0.000	4.200	4.200	1.000L	1.200L

Right hand support type 3 Compression flange laterally restrained.
Both flanges free to rotate on plan.
Beam fully restrained against torsion.

Design Loadcases

Dead, Type: Dead

Load Type	F [kN]	g1 [kN/m]	g2 [kN/m]	a [m]	b [m]	Stab type
UDL	-	13.5	-	0.000	4.200	Normal
Point load	7.0	-	-	1.200	-	Normal

Imposed, Type: Imposed

Load Type	F [kN]	g1 [kN/m]	g2 [kN/m]	a [m]	b [m]	Stab type
UDL	-	9.4	-	0.000	4.200	Normal

Design Combinations

Combination 1

Loadcase	Factor
Self weight	1.400
Dead	1.400
Imposed	1.600

Design Attributes

Section properties Europe
Selection criteria Weight

Size constraints

max. depth	350.0 mm
min. depth	50.0 mm
max. width	130.0 mm
min. width	100.0 mm

Deflection Limits

Dead loads	span/500	Apply Yes
Imposed loads	span/360	Apply Yes
Total loads	span/200	Apply Yes

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End Reactions Summary by Loadcase (Unfactored)

Loadcase	Reactions at supports	
	Left support [kN]	Right support [kN]
Self weight	1.0	1.0
Dead	33.3	30.3
Imposed	19.8	19.8

End Reactions Summary by Combination (Factored)

Combination	Reactions at supports	
	Left support [kN]	Right support [kN]
Combination 1	79.8	75.5

Design Summary

Design Condition	Check Status	Combination	Critical Value	Capacity or Limit	Units	Capacity Ratio
Vertical shear	Pass	1	79.8	461.8	kN	0.17
Moment	Pass	1	82.4	195.4	kNm	0.42
Buckling	Pass	1	82.4	96.1	kNm	0.86
Deflection	Pass	1	3.3	8.4	mm	0.39

Design Details

Combination 1

Vertical Shear check

Support: Left, critical

Item	Value	Units	Clause of BS 5950
Shear force, Fv	79.8	kN	
Design strength of steel, py	275.0	N/mm²	Part 1: 3.1.1, Table 6
Shear area, Av	27.99	cm²	Part 1: 4.2.3
Shear capacity, Pv	461.8	kN	Part 1: 4.2.3
Ratio	0.17		Part 1: 4.2.3
Pass			

Moment check

Position of: Maximum Moment, x = 2018.93, critical

Item	Value	Units	Clause of BS 5950
UB 305x127x48 S275			
Bending moment, M	82.4	kNm	
Shear force, Fv	0.0	kN	
Design strength of steel, py	275.0	N/mm²	Part 1: 3.1.1, Table 6
Shear capacity, Pv	461.8	kN	Part 1: 4.2.3
Section class	Plastic		Table 7
Plastic modulus, Sx	710.7	cm³	
Elastic modulus, Zx	615.7	cm³	
Moment capacity, Mc	195.4	kNm	Part 1: 4.2.5
Ratio	0.42		Part 1: 4.8.2
Pass			

Lateral Torsional Buckling check

Sub-beam No.: 1, critical

Item	Value	Units	Clause of BS 5950
UB 305x127x48 S275			
Position of the design moment, x	2.019	m	
Effective length, Le	4.200	m	Part 1: Table 9
Maximum moment, MA	82.4	kNm	
End moment ratio, Beta	1.00		
Equivalent uniform moment factor, m	1.00		Part 1: Table 13
Equivalent uniform moment, Mbar	82.4	kNm	Part 1: 4.3.7.2
Slenderness ratio, Lambda	153.06		Part 1: B.2.5.
Slenderness correction factor, n	0.94		Part 1: 4.3.7.6
Torsional index, x	23.34		Part 1: B.2.5.1
Slenderness factor, v	0.75		Part 1: B.2.5.1
Buckling parameter, u	0.87		Part 1: B.2.5.1

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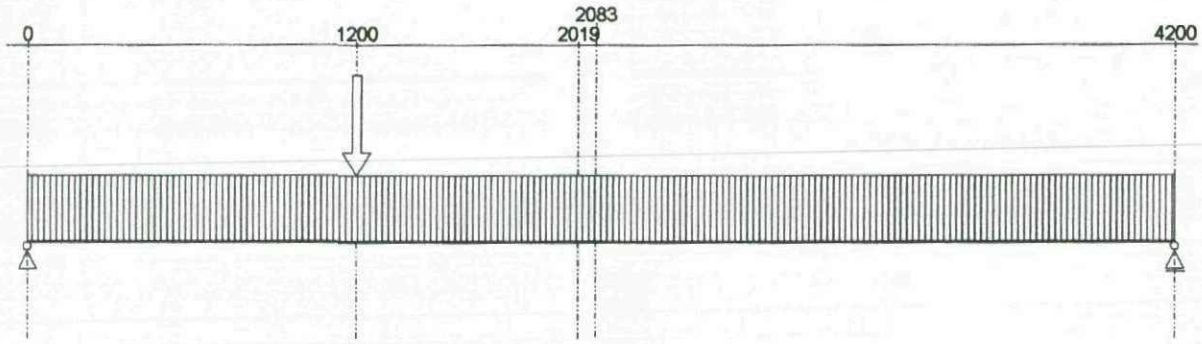
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Equivalent slenderness, LambdaLT	94.30		Part 1: B.2.5.1
Limiting slenderness, LambdaL0	34.31		Part 1: B.2.4
Perry coefficient, nLT	0.42		Part 1: B.2.3
Design strength of steel, py	275.0	N/mm²	Part 1: 3.1.1, Table 6
Plastic moment capacity, Mp	195.4	kNm	Part 1: B.2.1
Youngs's modulus, E	205000.0	N/mm²	
Elastic critical moment, ME	161.7	kNm	Part 1: B.2.2
Buckling index Phi,B	212.5	kNm	Part 1: B.2.1
Buckling resistance moment, Mb	96.1	kNm	Part 1: B.2.1
Ratio	0.86		Part 1: 4.3.7.1
Pass			

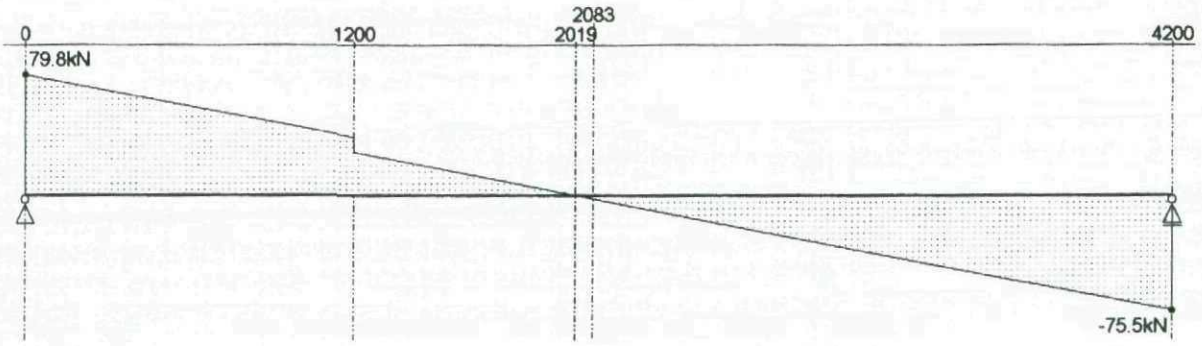
Deflection check

Item	Value	Units	Clause of BS 5950
Beam Span	4.200	m	
Dead Loads:			
Position of max. deflection	2.072	m	
Max. deflection	3.3	mm	
Deflection Limit	8.4	mm	
Ratio	0.39		
Imposed Loads:			
Position of max. deflection	2.100	m	
Max. deflection	2.0	mm	
Deflection Limit	11.7	mm	
Ratio	0.17		
Total Loads:			
Position of max. deflection	2.083	m	
Max. deflection	5.3	mm	
Deflection Limit	21.0	mm	
Ratio	0.25		
Pass			

Combination 1



Shear diagram



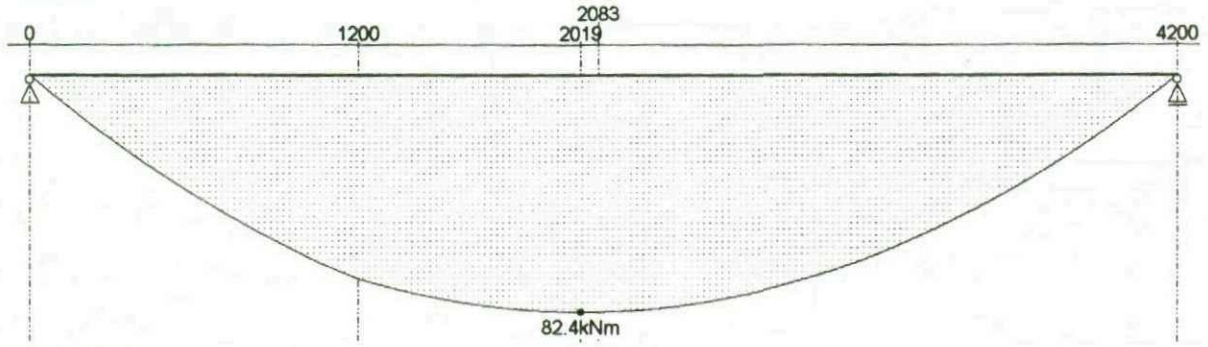
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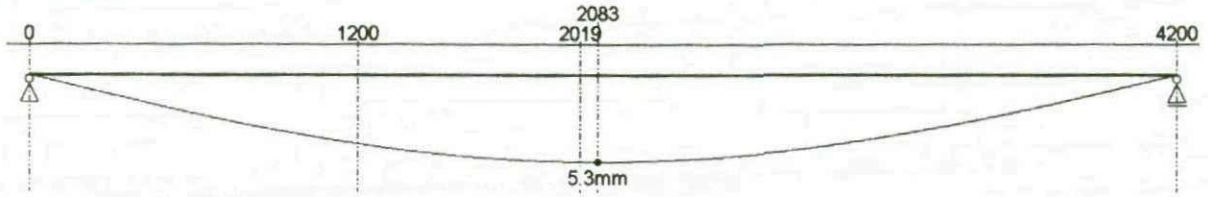
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Moment diagram



Deflection diagram



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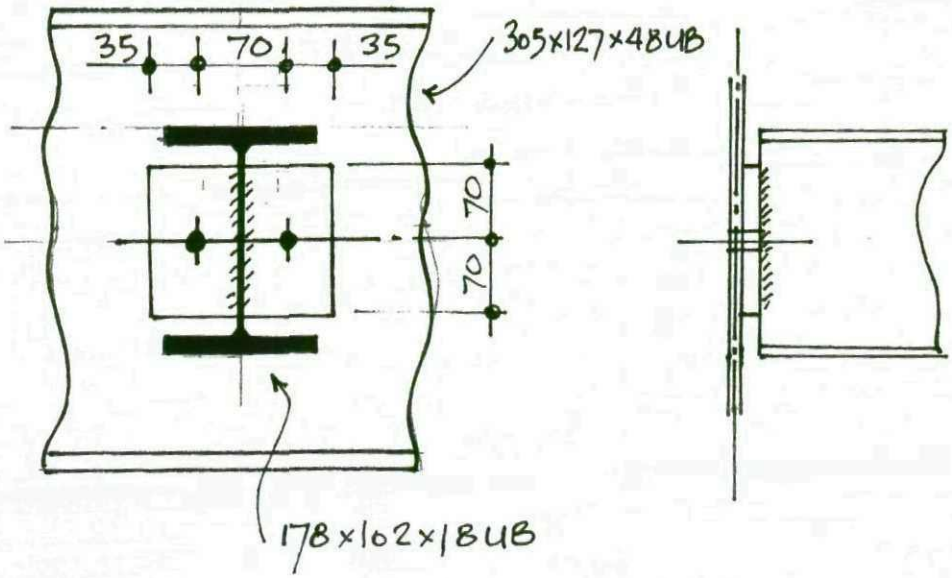
CALCULATIONS

REF | OUTPUT

Connection design

load = 9.83KN

Use a flexible endplate as detailed below



- Steel grade S275
- Bolts M20 Grade 8.8 $A_s = 245mm^2$
- Endplate 8mm thick
- 5mm fillet welds

Shear capacity of bolts

$P_s = A_s . p_s = 375 \times 245 \times 10^{-3} = 91.8KN$

$P_s = 2P_s = 183.6KN > 9.83KN$ OK

Bearing capacity of bolts

$P_{bs} = d.t.p_{bs} \leq 1/2.e.t.p_{bs}$

$\therefore$ $d.t.p_{bs} = 20 \times 6 \times 0.460 = 55.2 \times 2 = 110.4KN$

$1/2.e.t.p_{bs} = 70/2 \times 6 \times 0.460 = 96.6 \times 2 = 193.2KN$

$\therefore$ $110.4KN > 9.83KN$ OK.

SHEET NO: 12

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Shear capacity of welds

Length of weld = $2(L_w - 2N)$

$= 2(140 - 2\times5) = 260\text{mm}$

$\therefore$ Capacity $= 0.215 \times 5 \times 0.7 \times 260$

$= 195.65\text{ kN} > 9.83\text{ kN}$ OK

$\therefore$ Adopt endplate connection as follows:-

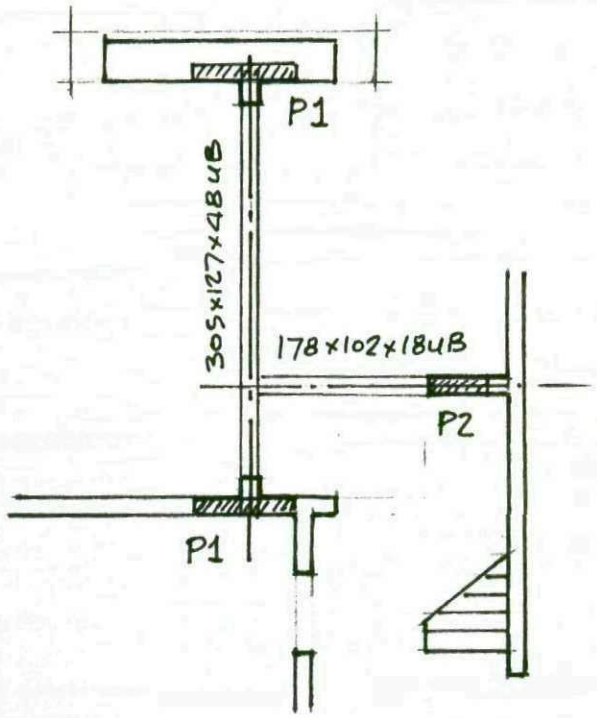
2 N.° M20 bolts + 140×140×6 endplate welded to 178×102×18UB with 5mm fillet welds. Plate to have 2 N.° 22mm ϕ holes. All steelwork to be S275. All bolts to be Grade 8.8.

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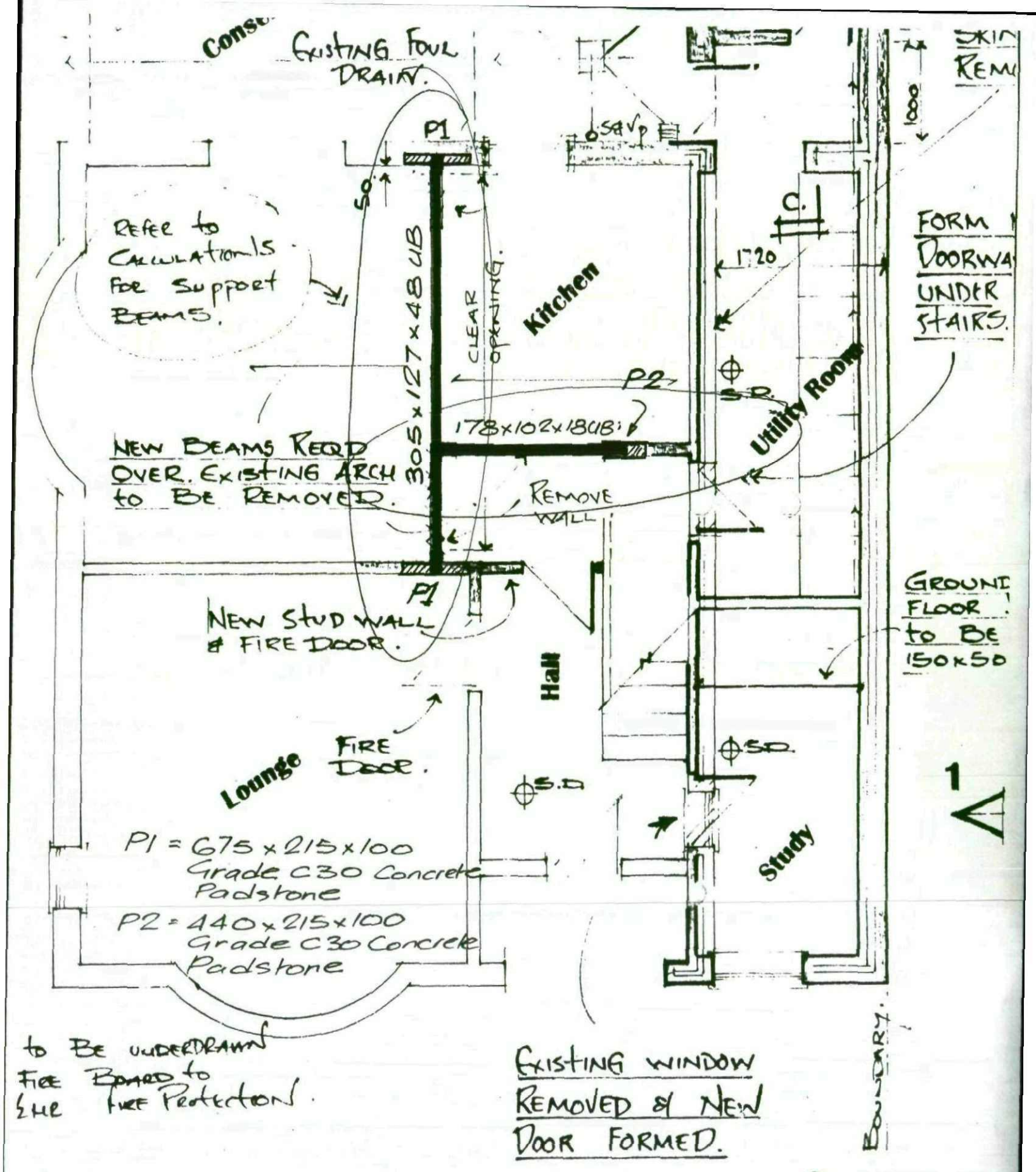
REF		OUTPUT



P1 = 675 x 215 x 100
Grade C30
Concrete padstone

P2 = 440 x 215 x 100
Grade C30
Concrete
padstone

PLAN ON BEAM ARRANGEMENT



sting / Proposed Ground Floor Plan

IF RADON IS REQUIRE 2000 G. U ALL JOINT: CONTINUE