AJS Structural Design Ltd.

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Sheet no. 1	Rev. B
Prepared by: MP	Date: APRIL' 16
Checked by: BD	Date: APRIL' 16
Title of Scheme: ASTON-ON-TRENT PAVILION	Job no: A2680

STRUCTURAL CALCULATIONS
FOR THE
PROPOSED ALTERATIONS
TO
ASTON-ON-TRENT PAVILION,
ASTON-ON-TRENT,
DERBYSHIRE

PREPARED IN ACCORDANCE WITH THE RELEVANT PARTS OF THE FOLLOWING CODES OF PRACTICE:-

BS 6399 LOADINGS FOR BUILDINGS

BS 5950 STRUCTURAL USE OF STEELWORK

BS 5628 USE OF MASONRY

BS 5268 STRUCTURAL USE OF TIMBER

BS 8110 STRUCTURAL USE OF CONCRETE

BS 8004 FOUNDATIONS

DATE: APRIL 2016

REF: A2680

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Sheet no. 3	Rev. B
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1. FLOOR JOISTS

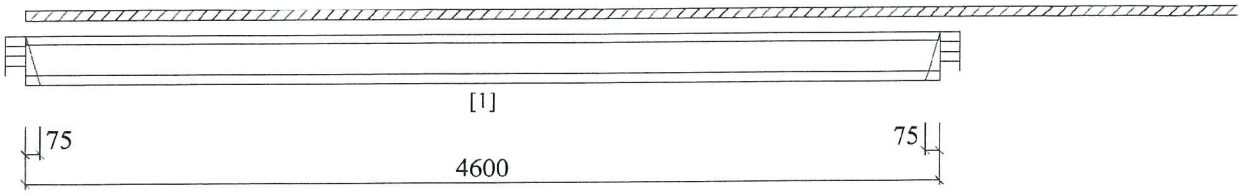
MAX SPAN = 3.7m

Joist Details **(Serviceability Index = 1.035)**

Joist Type JJI245D-24 Placement Floor (Intermediate)
Joist Ref.
Joist Size 97.0 x 245.0 Flange: 97.0 x 45.0 C24 Softwood Web 9.0mm OSB/3
Approval Cert. No. 10/0355

Girder No
Centres 300
Quantity 1

Stock Joist
Cut Len 4.600m
Stock Len 4.600m
Weight 22.40kg



Loading Details

Load Duration Factor K_3 Long Term 1.00 Medium Term 1.25 Short Term 1.50 Load Sharing Factor. K_8 1.10
Standard Loads. (kN/m²) No Load Imposed 0.000 Dead 0.000
Additional Loads. (kN/m², kN, kN/m) (As defined by User.)

Type	Dur	Dir	Load		At	Start	End	Ctrs	Dist	Qty
Uniform	Long	V	6.000	(1.000)	-	0	6380	-	-	-

Joist Properties

Section Area 10125.00mm² Flexural Rigidity (EI) 1195.40E⁹ Nmm² Shear Rigidity (GA) 1.26E⁶ N Max. Deflection = Span * 0.003 or 12.0mm

Design Results

	Shear (kN)				Bearing (kN)				Bending (kNm)				Deflection (mm)			
	Actual	Permiss	CSI	LC	Actual	Permiss	CSI	LC	Actual	Permiss	CSI	LC	Actual	Permiss	CSI	LC
Long Term	3.644	5.038	72%	All	4.140	4.284	97%	All	4.544	5.720	79%	All	11.593	12.000	97%	All

Reactions @ Supports (kN)	1	2
Long Term	4.140 (0.690)	4.140 (0.690)

		Long Term		
Max Shear Force	(kN)	3.644	@	4547mm
Max Bearing Reaction	(kN)	4.140	@	53mm
Max Bending Moment	(kNm)	4.544	@	2300mm
Max Deflection	(mm)	11.593	@	2300mm

Hanger Requirements:
Left: Cullen - Model: JHI 100/240 Mark: Stock Hanger
Right: Cullen - Model: JHI 100/240 Mark: Stock Hanger

Notes

Joists are designed in accordance with BS5268 Part 2:2002, TRADA ETA-10/0355. Results are only valid for use within the UK, where the joists are correctly installed in accordance with a current version of the Installation Guide issued by James Jones & Sons Limited, Timber Systems Division.
Joist designed as a Floor (Intermediate) Joist. (Standard Imposed Load treated as Long Term).
All Start & End dimensions are in mm, referenced from the left edge of the joist.If Support web stiffners required, supports are numbered from the left.
If Load web stiffners or Restraint blocking are required, dimensions given are to the centre line position, referenced from the left edge of the joist.

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Joist Details **(Serviceability Index = 1.035)**

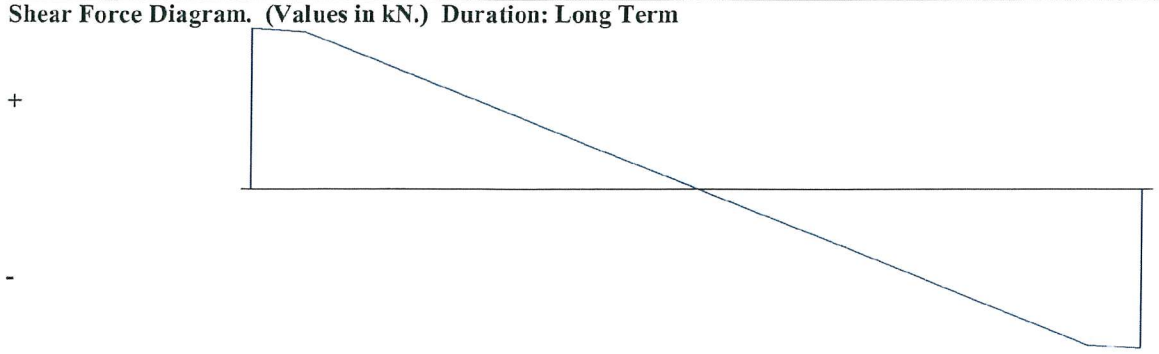
Joist Type JJI245D-24 Placement Floor (Intermediate)
Joist Ref.
Joist Size 97.0 x 245.0 Flange: 97.0 x 45.0 C24 Softwood Web 9.0mm OSB/3
Approval Cert. No. 10/0355

Girder No
Centres 300
Quantity 1

Stock Joist
Cut Len 4.600m
Stock Len 4.600m

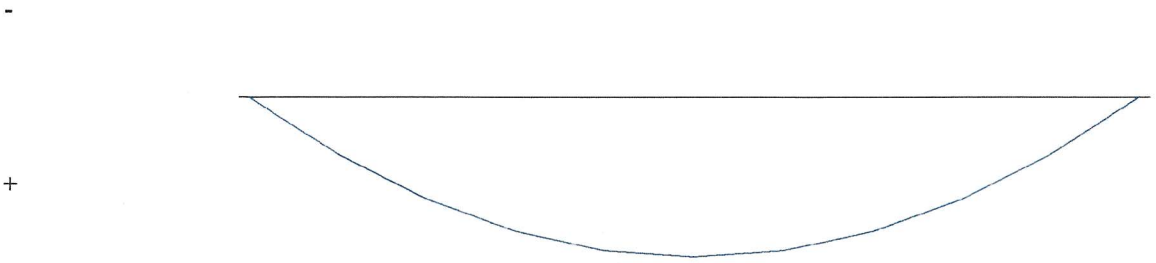
Weight 22.40kg

Shear Force Diagram. (Values in kN.) Duration: Long Term



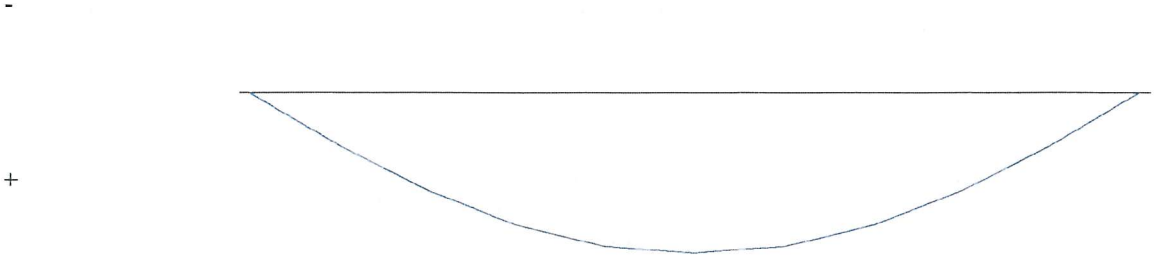
3.64 @ 53mm	3.56 @ 320mm	-3.56 @ 4280mm	-3.64 @ 4547mm

Bending Moment Diagram. (Values in kNm.) Duration: Long Term



0.00 @ 53mm	4.54 @ 2300mm	0.00 @ 4547mm

Deflection Diagram. (Values in mm.) Duration: Long Term



0.00 @ 53mm	11.59 @ 2300mm	0.00 @ 4547mm

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GENERAL LOADING

ROOF	SUPER	= **0.6 kN/m²**
	DEAD	= **0.9 kN/m²**
CEILING	SUPER	= **0.25 kN/m²**
	DEAD	= **0.35 kN/m²**
1st FLOOR	SUPER	= **5.0 kN/m²**
	DEAD :	
	BOARDING	= 0.15 kN/m²
	JOIST SWT	= 0.15 kN/m²
	CEILING	= 0.15 kN/m²
		0.45 kN/m²
MASONRY	100mm BRW	= **2.1 kN/m²**
	100mm BLW	= **0.9 kN/m²**
	PLASTER	= **0.2 kN/m²**

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1. FLOOR JOISTS

MAX SPAN = 3.7m

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2. BEAM SUPPORTING FLOOR

MAX EFFECTIVE LENGTH = 6.4m

UDL

								UNFACTORED				**FACTORED**	
1ST FLOOR SUPER	=	5	x	6.4	x	4.6	=	147.20	x	1.6	=	235.52	
1ST FLOOR DEAD	=	1	x	6.4	x	4.6	=	29.44	x	1.4	=	41.22	
BEAM SWT	=	1.07	x	6.4			=	6.85	x	1.4	=	9.59	
								183.49	**kN**			**286.32**	**kN**
Mult	=	286.3	x	6.4	/	8	=	**229.1**	**kNm**				
Δ LIMIT	=	6.4	/	0.360			=	**17.8**	**mm**				
Ixx	=	2.23	x	183.5	x	6.4	x	6.4	=	**16759.9**	**cm^4**		

USE CRANKED 254 x 254 x 107UC (Mb= 313kNm, Ixx= 17510cm^4)

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3. BEAM OVER STAIRS

MAX EFFECTIVE LENGTH = 1.7m

UDL

								UNFACTORED				FACTORED	
WALL	=	1.3	x	1.7	x	2.4	=	5.30	x	1.4	=	7.43	
1ST FLOOR SUPER	=	5	x	1.7	x	0.8	=	6.80	x	1.6	=	10.88	
1ST FLOOR DEAD	=	1	x	1.7	x	0.8	=	1.36	x	1.4	=	1.90	
BEAM SWT	=	0.23	x	1.7			=	0.39	x	1.4	=	0.55	
								13.86	**kN**			**20.76**	**kN**

Mult	=	20.8	x	1.7	/	8	=	**4.4**	**kNm**		
Δ LIMIT	=	1.7	/	0.360			=	**4.7**	**mm**		
Ixx	=	2.23	x	13.9	x	1.7	x	1.7	=	**89.3**	**cm^4**

USE 178 x 102 x 19UB (Mb= 34.2kNm, Ixx= 1356cm^4)

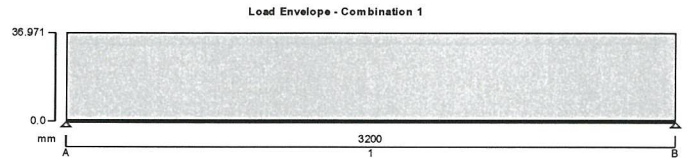
4. CHECK DOUBLE BEAM OVER COMMUNITY SPACE (IF REQUIRED)

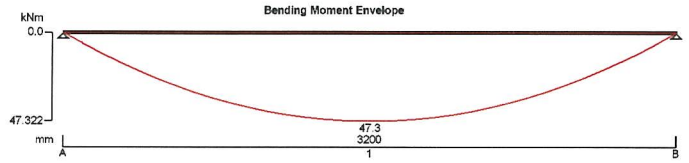
MAX EFFECTIVE LENGTH = 3.2m

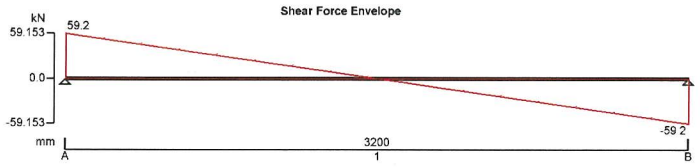
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.05







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Dead full UDL 6.05 kN/m
	Imposed full UDL 2.73 kN/m
	Dead full UDL 4.095 kN/m
	Dead full UDL 1.14 kN/m
	Dead full UDL 11.55 kN/m
	Dead self weight of beam × 1

Load combinations

Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
	Span 1	Dead × 1.40
		Imposed × 1.60

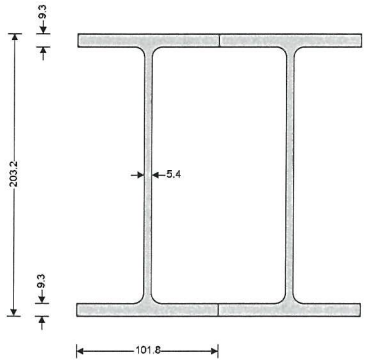
	Support B	Dead × 1.40 Imposed × 1.60

Analysis results

Maximum moment	M_{max} = **47.3** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **59.2** kN	V_{min} = **-59.2** kN
Deflection	δ_{max} = **4.1** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **59.2** kN	R_{A_min} = **59.2** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **37.3** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **4.4** kN	
Maximum reaction at support B	R_{B_max} = **59.2** kN	R_{B_min} = **59.2** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **37.3** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **4.4** kN	

Section details

Section type **2 x UKB 203x102x23** Steel grade **S275**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **1.00** Section classification **Plastic**

Shear capacity - Section 4.2.3

Design shear force F_v = **59.2** kN Design shear resistance P_v = **362.1** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment M = **47.3** kNm Moment capacity low shear M_c = **128.7** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment M_b = **64.5** kNm M_b / m_{LT} = **69.8** kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

Limiting deflection δ_{lim} = **8.889** mm Maximum deflection δ = **4.116** mm

PASS - Maximum deflection does not exceed deflection limit

ENSURE MIN BEAM SIZES ARE 2/203 x 102 x 23UBS

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5. CHECK FLOOR SUPPORT BEAM OVER KITCHEN

MAX EFFECTIVE LENGTH = 2.3m

UDL

									UNFACTORED				FACTORED	
1ST FLOOR SUPER	=	5	x	2.3	x	2.6	=	29.90	x	1.6	=	47.84		
1ST FLOOR DEAD	=	1	x	2.3	x	2.6	=	5.98	x	1.4	=	8.37		
BEAM SWT	=	0.23	x	2.3			=	0.53	x	1.4	=	0.74		
								36.41	**kN**			**56.95**	**kN**	

Mult	=	57.0	x	2.3	/	8	=	**16.4**	**kNm**		
Δ LIMIT	=	2.3	/	0.360			=	**6.4**	**mm**		
Ixx	=	2.23	x	36.4	x	2.3	x	2.3	=	**429.5**	**cm^4**

ENSURE MIN BEAM SIZE IS 178 x 102 x 19UB

(Mb= 29.1kNm, Ixx= 1356cm^4)

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6. NEW DOUBLE BEAM OVER MALE WC

MAX EFFECTIVE LENGTH = 3.4m

UDL

INNER SIDE								UNFACTORED				FACTORED	
WALL	=	1.1	x	3.4	x	4	=	14.96	x	1.4	=	20.94	
1ST FLOOR SUPER	=	5	x	3.4	x	2.3	=	39.10	x	1.6	=	62.56	
1ST FLOOR DEAD	=	1	x	3.4	x	2.3	=	7.82	x	1.4	=	10.95	
BEAM SWT	=	0.4	x	3.4			=	1.36	x	1.4	=	1.90	
								63.24	**kN**			**96.36**	**kN**
Mult	=	96.4	x	3.4	/	8	=	**41.0**	**kNm**				
Δ LIMIT	=	3.4	/	0.360			=	**9.4**	**mm**				
Ixx	=	2.23	x	63.2	x	3.4	x	3.4	=	**1630.3**	**cm^4**		

OUTER SIDE								UNFACTORED				FACTORED	
WALL	=	2.1	x	3.4	x	4	=	28.56	x	1.4	=	39.98	
BEAM SWT	=	0.4	x	3.4			=	1.36	x	1.4	=	1.90	
								29.92	**kN**			**41.89**	**kN**
Mult	=	41.9	x	3.4	/	8	=	**17.8**	**kNm**				
Δ LIMIT	=	3.4	/	0.360			=	**9.4**	**mm**				
Ixx	=	2.23	x	29.9	x	3.4	x	3.4	=	**771.3**	**cm^4**		

USE MIN 2/203 x 133 x 30UBS BOLTED TOGETHER AT 600mm C/C USING M16 8.8g BOLTS AND SPACERS WITH A CHANNEL @ MIDSPAN (Mb= 40.5 kNm, Ixx= 2340cm^4)

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7. CHECK ADEQUACY OF NEW 100mm 3.5N BLOCK WALL

UNDER VERTICAL LOAD

LOAD = 163.75 kN = **24.44 kN/m**

HEIGHT = 2.4 m

SLENDERNESS RATIO = 2.4 / 0.1 = **24.0 < 27** **OK**

fK = 3.5 x (0.7 + 1.5 x 6.7 x 0.1) = **6.0**

TRY 100mm WALL USING 3.5N BLOCKWORK

$$\text{DVLR} = \frac{0.47 \times 100 \times 6.0}{3.1} = \textbf{90.5 kN/m} > \textbf{24.44 kN/m}$$

ADOPT MIN 100mm THICK 3.5N BLOCKWORK WALL

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8. CHECK FOUNDATION UNDER NEW 100mm 3.5N BLOCK WALL

GROUND AT FORMATION LEVEL ASSUMED TO BE NATURAL UNDISTURBED AND CAPABLE OF SAFELY SUPPORTING 150kN/m^2.

Try a 450 WIDE x 600 DEEP STRIP FOOTING

			kN / m
1st Floor:	5.00 x 2.6	=	13
1st Floor:	1.00 x 2.6	=	2.6
Wall	1.3 x 4.8	=	6.24
O/Burden	0.45 x 0.3 x 20	=	2.7
Strip	0.45 x 0.6 x 24	=	6.48
	TOTAL	=	**31.02** kN / m.

Ground Bearing Pressure GBP = 31.02 / 0.45 = 69 < 150 kN/sq.m. **O.K.**

ADOPT A MIN 450MM WIDE X 600MM DEEP C25 CONCRETE FOOTING WITH FORMATION LEVEL MIN 900mm BELOW GROUND LEVEL BUT TO APPROVAL OF BUILDING INSPECTOR IN NATURAL UNDISTURBED GROUND CAPABLE OF SAFELY SUPPORTING 150kN/m^2

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9. CHECK FLOOR SUPPORT BEAM OVER KITCHEN

MAX EFFECTIVE LENGTH = 1.3m

UDL

									UNFACTORED				FACTORED	
STAIRS SUPER	=	5	x	1.3	x	1.8	=	11.70	x	1.6	=	18.72		
STAIRS DEAD	=	7.2	x	1.3	x	1.8	=	16.85	x	1.4	=	23.59		
BEAM SWT	=	0.2	x	1.3			=	0.26	x	1.4	=	0.36		
								28.81	**kN**			**42.67**	**kN**	
Mult	=	42.7	x	1.3	/	8	=	**6.9**	**kNm**					
Δ LIMIT	=	1.3	/	0.360			=	**3.6**	**mm**					
Ixx	=	2.23	x	28.8	x	1.3	x	1.3	=	**108.6**	**cm^4**			

USE 178 x 102 x 19UB

(Mb= 40.1kNm, Ixx= 1356cm^4)

10. LINTEL BEAM OVER STORAGE ROOM DOOR UNDER STAIRS

EFFECTIVE LENGTH = 1.6m

UDL

								UNFACTORED					**FACTORED**	
WALL SWT	=	1.3	x	1.6	x	2.4	=	4.99	x	1.4	=	6.99		
BEAM SWT	=	0.2	x	1.6			=	0.32	x	1.4	=	0.45		
								5.31	**kN**			**7.44**	**kN**	
P.L @ 0.4m	=	14.41	kN	=	21.34	ULT								
Mult	=	7.4	x	1.6	/	8								
	+	21.3	x	0.4	x	1.2	/	1.6	=	**7.9**	**kNm**			
Δ LIMIT	=	1.6	/	0.360			=	**4.4**	**mm**					
Ixx	=	2.23	x	5.3	x	1.6	x	1.6						
	+	2.23	x	1.125	x	14.4	x	1.6	x	1.6	=	**122.9**	**cm^4**	

USE 178 x 102 x 19UB

(Mb= 38.92kNm, Ixx= 1356cm^4)

11. CHECK FOUNDATION FOR TOE OF CONCRETE STAIRS

GROUND AT FORMATION LEVEL ASSUMED TO BE NATURAL UNDISTURBED AND CAPABLE OF SAFELY SUPPORTING 150kN/m^2.

Try a 600 WIDE x 600 DEEP STRIP FOOTING

			kN / m
Stair S:	5.00 x 1.8	=	9
Stair D:	7.2 x 1.8	=	12.96
O/Burden	0.6 x 0.3 x 20	=	3.6
Strip	0.6 x 0.6 x 24	=	8.64
	TOTAL	=	**34.2** kN / m.

Ground Bearing Pressure GBP = 34. 2 / 0.6 = 57 < 150 kN/sq.m. **O.K.**

ADOPT A MIN 600MM WIDE x 600MM DEEP C25 CONCRETE FOOTING WITH FORMATION LEVEL MIN 900MM BELOW GROUND LEVEL BUT TO APPROVAL OF BUILDING INSPECTOR IN NATURAL UNDISTURBED GROUND CAPABLE OF SAFELY SUPPORTING 150KN/M^2

12. CHECK FOUNDATION UNDER WALL

GROUND AT FORMATION LEVEL ASSUMED TO BE NATURAL UNDISTURBED AND CAPABLE OF SAFELY SUPPORTING 150kN/m^2.

Try a 900 WIDE x 600 DEEP STRIP FOOTING

			kN / m
Wall:	3.6 x 2.4	=	8.64
PL:		=	102.75
O/Burden	0.6 x 0.3 x 20	=	3.6
Strip	0.6 x 0.6 x 24	=	8.64
	TOTAL	=	**123.63** kN / m.

Ground Bearing Pressure = 123.63 / 0.9 = 137 < 150kN/sq.m. **O.K.**

ADOPT A MIN 900MM WIDE x 600MM DEEP C25 CONCRETE FOOTING WITH FORMATION LEVEL MIN 900MM BELOW GROUND LEVEL BUT TO APPROVAL OF BUILDING INSPECTOR IN NATURAL UNDISTURBED GROUND CAPABLE OF SAFELY SUPPORTING 150KN/M^2

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PADSTONE UNDER BEAM 2

MAX BEAM REACTION = 286.32 / 2 = **143.16 kN**

STRESS ON TOP OF PADSTONE = $\frac{143.16 \times 10^3}{252 \times 100}$ = **5.68 N/mm²**

PERMISSIBLE STRESS = 0.4 x 25 = **10.00 N/mm² > 5.68 N/mm²**

CHECK STRESS TO U/S OF PADSTONE

ACTUAL = $\frac{143.16 \times 10^3}{450 \times 200}$ = **1.59 N/mm²**

PERMISSIBLE = $\frac{1.5 \times 3.5}{3.1}$ = **1.69 N/mm² > 1.59 N/mm²**

USE MIN 450mm LONG x 200mm WIDE x 450mm DEEP MASS C25 CONCRETE PADSTONE

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Sheet no. **18**	Rev. **B**
Prepared by: **MP**	Date: **APRIL' 16**
Checked by: **BD**	Date: **APRIL' 16**
Title of Scheme: **ASTON-ON-TRENT PAVILION**	Job no: **A2680**

PADSTONES FOR REMAINING BEAMS

MAX BEAM REACTION = 56.95 / 2 = **28.475 kN**

STRESS ON TOP OF PADSTONE = $\frac{28.475 \times 10^3}{102 \times 100}$ = **2.79 N/mm²**

PERMISSIBLE STRESS = $\frac{1.5 \times 5.8}{3.1}$ = **2.81 N/mm² > 2.79 N/mm²**

CHECK STRESS TO U/S OF PADSTONE

ACTUAL = $\frac{28.475 \times 10^3}{450 \times 100}$ = **0.63 N/mm²**

PERMISSIBLE = $\frac{1.5 \times 3.5}{3.1}$ = **1.69 N/mm² > 0.63 N/mm²**

USE MIN 450mm LONG x 3 COURSE DEEP COMMON BRICKWORK PADSTONE IN A CLASS III MORTAR