Engineering Design & Analysis 5 Sanderstead Hill South Croydon CR2 0HB	Project				Job Ref.
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	ועם	24/04/2010			Rev D: Ballast added 22.04.18
	КПJ	24/04/2010			Rev E: Sedum/paving removed 24.04.18

Summary of Outcome of Calculations on Capacity of Existing Roofs

- With ballasting, the joists and frame beams are compliant, provided the equivalent "footprint" of the panels in sedum or paving is removed.
- Where the sedum/paving is not removed, the existing structure is marginally non-compliant.

Calculations

Timber sizes taken from original drawings - Grade C24 timber throughout. Calculations to BS5268-2:2002

Original Building

Check on Joists and Main (Frame) Beams - roof finishes include paving slabs

Dead Load: Say 1.6kN/m² (either layer of sedum or paving slabs) Live Load: 0.75+0.4 (solar panels plus ballast): say 1.2kN/m²

Where sedum/paving is removed, net dead load is say 0.7kN/m²

From drawing 685/S/03:

Joists are 50 x 250 Grade C24 at 600 centres

For loading above:

JOISTS FROM ORIGINAL DRAWINGS

TIMBER JOIST DESIGN (BS5268-2:2002)

Joist details

Joist breadth	b
Joist spacing	s
Timber strength class	С

b = 47 mm s = 600 mm C24 Joist depth Service class of timber h = 250 mm 1

Tedds calculation version 1.1.04

mm [______A

Span details

Number of spans Clear length of span $N_{span} = 1$ $L_{s1} = 4550 \text{ mm}$ Length of bearing

4550

 $L_b = 100 \text{ mm}$

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250				<			
4 47 →							
		↓ 100					
Section properties	I - 61107017 /	mm ⁴	Section module	10	$7 - 480583 \text{ mm}^3$		
	1=011979171	11111	Section modulus		Z = 409505 mm*		
Joist self weight	$F_{\text{sut}} = 0.04 \text{ kN/m}$		Dead load		$F_{d,udl} = 0.70 \text{ kN/m}^2$		
Imposed UDL(Long term)	$F_{i_{udl}} = 1.20 \text{ kN}$	$F_{i udl} = 1.20 \text{ kN/m}^2$					
Imposed point load (Medium)	F _{i_pt} = 1.40 kN						
Consider long term loads							
Design bending moment	M = 3.054 kNr	n	Design shear force		V = 2.685 kN		
Design support reaction	R = 2.685 kN		Design deflection		δ = 10.428 mm		
Check bending stress							
Permissible bending stress	$\sigma_{m_adm} = 8.417$	$\sigma_{m_adm} = 8.417 \ N/mm^2$		Applied bending stress $\sigma_{m_max} = 6.239$ PASS - Applied bending stress within permi			
Check shear stress							
Permissible shear stress	$\tau_{adm} = 0.781 \text{ N}$	/mm²	Applied shear	stress	$\tau_{max} = 0.343 \text{ N/mm}^2$		
	PASS - Applied shear stress within permis						
Check bearing stress							
Permissible bearing stress	$\sigma_{c_adm} = 2.640$	N/mm ²	Applied bearing	g stress	$\sigma_{c_{max}} = 0.571 \text{ N/mm}^2$		
			PASS - Applie	ed bearing stre	ss within permissible limits		
Check deflection	\$ 40.050				\$ 40.400		
Permissible deflection	ð _{adm} = 13.650 mm		PASS - Actual deflection within per		o = 10.428 mm		
			1400				
Consider medium term load	<u>S</u> M – 2 784 kNr	n	Design shear f	orce	V = 2.447 kN		
Design support reaction	R = 2.447 kN		Design deflection		$\delta = 8.465 \text{ mm}$		
Check bending stress							
Permissible bending stress $\sigma_{m adm} = 10.521 \text{ N/mm}^2$ Applied bending stress					σ _{m max} = 5.686 N/mm ²		
			PASS - Applied bending stress within permissi				
Check shear stress				-			
Permissible shear stress	$\tau_{adm} = 0.976 \text{ N}$	/mm²	Applied shear	stress	$\tau_{max} = 0.312 \text{ N/mm}^2$		
			PASS - Applied shear stress within permissible limits				



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Applied loading					
Beam loads					
		Dead self v	veight of beam >	< 1	
		Dead full L	IDI 1 400 kN/m		
		Imposed fu	ull UDI 2 400 kN	l/m	
		inpeccure			
Load combinations					
Load combination 1		Support A		$Dead \times$	1.00
				Imposed	d×1.00
		Span 1		$Dead\times$	1.00
				Imposed	1×1.00
		Support B	Dead×		1.00
				Imposed	1×1.00
Analysis results			Desire sheer		
Tetal load on beam	W = 1.554 KINITI		Design shear		F = 3.454 kin
Poterione et europert A	$VV_{tot} = 0.908 \text{ km}$		D 24541	~N1	
Reactions at support A	$RA_{max} = 3.454 $ K	D 1	$RA_{min} = 3.4341$		
		RA_Dead = I	.294 KN		
Dilactored imposed load reacti		RA_Imposed =	= 2.100 KIN	~N1	
Reactions at support B	$R_{B_{max}} = 3.454 $ k		$R_{B_{min}} = 3.454 I$	KIN	
Unfactored dead load reaction a	at support B	RB_Dead = 1	.294 KIN		
		RB_Imposed =	= 2.100 KIN		
S V				\leq	
T //					
\downarrow / \backslash					
4 7 ↓					
	■ 100 —				
Timber section details					
Breadth of section	b = 47 mm		Depth of sectio	n	h = 195 mm
Number of sections	N = 1		Breadth of bear	m	$b_b = 47 \text{ mm}$
Timber strength class	C24				
Member details					
Service class of timber	1		Load duration		Long term
Length of span	L _{s1} = 1800 mm				
Length of bearing	L _b = 100 mm				
l ateral support - cl 2 10 8					
Permiss depth-to-breadth ratio	5.00		Actual depth-to	-breadth ratio	1 15
	5.00				toral sunnort is adequate
				7 A00 - E0	iteral support is adequate
Check bearing stress					
Permissible bearing stress	$\sigma_{c_{adm}} = 2.400 N$	I/mm²	Applied bearing	g stress	$\sigma_{c_a} = 0.735 \text{ N/mm}^2$
PASS - Applied compressive stress is less than permissible compressive stress at bearing					
Bending parallel to grain					
Permissible bending stress	σ _{m_adm} = 7.864 Ι	N/mm²	Applied bending	g stress	$\sigma_{m_a} = 5.218 \text{ N/mm}^2$
5				-	



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					···· = = = = = = = = = = = = = = = = =
		Imposed fu	III UDL 4.800 kN	l/m	
Load combinations					
Load combination 1		Support A		Dead	× 1.00
				Impos	ed imes 1.00
		Span 1		Dead	× 1.00
		·		Impos	ed imes 1.00
		Support B		Dead	× 1.00
		0pp 0 2		Impos	$ed \times 1.00$
				mpee	
Analysis results	M 0.000 LNI		Decime ale com		
	M = 3.838 kNm		Design shear		F = 7.675 KN
l otal load on beam	$VV_{tot} = 15.351 \text{ kl}$	N			
Reactions at support A	$R_{A_{max}} = 7.675$	KN D	$R_{A_{min}} = 7.675$	٨N	
Unfactored dead load reaction	at support A	$R_{A}Dead = 2$.875 KN		
Unfactored imposed load reacti	on at support A	RA_Imposed =	4.800 kN		
Reactions at support B	$R_{B_{max}} = 7.675$	KN D	$R_{B_{min}} = 7.675$	KN	
Unfactored dead load reaction	at support B	$R_{B}Dead = 2$.875 KN		
	on at support B	RB_Imposed =	= 4.800 KIN		
	\sim	1			
		- -			
	- 100- -	•]			
Timbor soction dotails					
Breadth of section	h – 47 mm		Depth of sectio	n	h – 195 mm
Number of sections	D = 47 mm		Breadth of beau	m	h = 195 mm
Timber strength class	N = 2		Dieautii oi bea	11	$D_{\rm b} = 94$ mm
	024				
Member details					
Service class of timber	1		Load duration		Long term
Length of span	$L_{s1} = 2000 \text{ mm}$				
Length of bearing	$L_{b} = 100 \text{ mm}$				
Lateral support - cl.2.10.8					
Permiss.depth-to-breadth ratio	4.00		Actual depth-to	-breadth ratio	2.07
				PASS -	Lateral support is adequate
Check bearing stress					
Permissible bearing stress	σ _{c_adm} = 2.400 №	N/mm²	Applied bearing	g stress	$\sigma_{c_a} = 0.817 \text{ N/mm}^2$
PAS	S - Applied com	npressive stres	s is less than p	ermissible co	mpressive stress at bearing
Bending parallel to grain					
Permissible bending stress	$\sigma_{m,adm} = 7.864$	N/mm ²	Applied bendin	a stress	$\sigma_{m,a} = 6.442 \text{ N/mm}^2$
		PASS - Annlie	d bending stres	s is less than	permissible bending stress
Choose novellates and the				e .eee andii	
Siliear parallel to grain	- 0740 N/				- 0.600 N/2
remissible shear stress	$\tau_{adm} = 0.710$ N/I		Applied snear s		$t_a = 0.020$ N/IIIIII ²
		PASS - A	pplied snear st	ress is less th	an permissible snear stress

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Deflection					
Permissible deflection	$\delta_{adm} = 6.000 \text{ mm}$	m	Total deflectio	n	$\delta_a = 4.382 \text{ mm}$
		P.	ASS - Total de	flection is les	s than permissible deflection