CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No. jXXX	Sheet No. 1	Rev.
		Member/Location		
Job Title	Structure, Member Design - Precast Concrete Frame, B	Drg. Ref.		
Structure, Member Design - PC Frame, Beam and Slab		Made by XX	Date 30/11/2024	Chd.

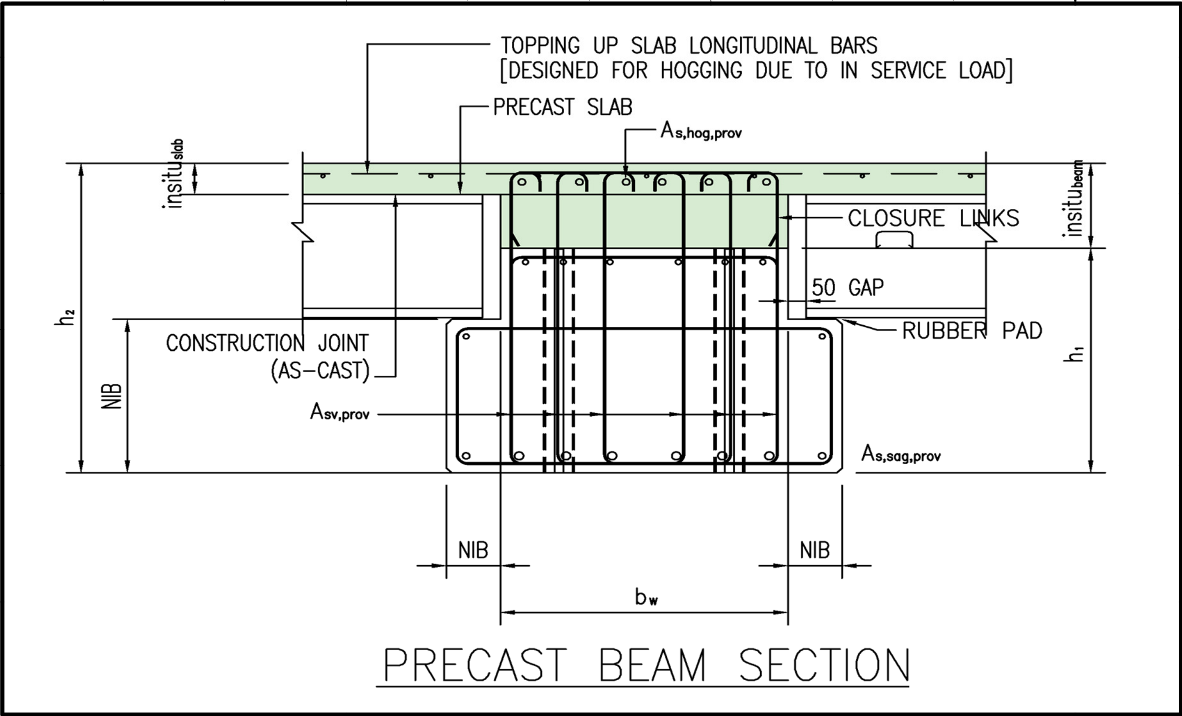
			BS8110
Material Properties			
Characteristic strength of concrete, f_{cu} / f_c' (f_{cu} ≤ 75 or 105N/mm^2; 55	45	N/mm^2	OK
Yield strength of longitudinal steel, f_y	460	N/mm^2	
Yield strength of shear link steel, f_{yv}	460	N/mm^2	
Type of concrete and density, ρ_c — Normal Weight 25kN/m3	25	kN/m^3	
Section Dimensions and Reinforcement [Stage 1: Precast Simply-Supported]			
Slab insitu depth, $insitu_{slab}$	100	mm	
Beam (precast) width, b_{w1} = b_w	500	mm	
Beam (precast) depth, h_1	700	mm	
Cover, $cover_{bot1}$ (usually 35 (C35) or 30 (C40) internal; 40 external)	25	mm	
Sag steel reinforcement diameter, ϕ_{t1}	32	mm	
Sag steel reinforcement number, n_{t1}	8		
Sag steel area provided, $A_{s,sag,prov}$ = $n_{t1}.\pi.\phi_{t1}^2/4$	6434	mm^2	
Number of layers of sag steel, $n_{layers,sag1}$	2	layer(s)	
Spacer for sag steel, $s_{r,sag1}$ (≥ MAX (ϕ_{t1}, 25mm))	32	mm	OK
Shear link diameter, ϕ_{link}	10	mm	
Number of shear links in a cross section, i.e. number of legs, n_{leg}	4		
Area provided by all shear links in a cross-section, $A_{sv,prov}$ = $\pi.\phi_{link}^2/4.n_{leg}$	314	mm^2	
Pitch of shear links, S	100	mm	
Eff. depth to sag steel, d_{sag1} = h_1 - $cover_{bot1}$ - ϕ_{link} - [ϕ_{t1}+($n_{layers,sag1}$-1)(ϕ_{t1}+$s_{r,sa}$	617	mm	
Section Dimensions [Stage 2: Insitu]			
Beam (composite) width, b_{w2} = b_w	500	mm	
Beam insitu depth, $insitu_{beam}$	300	mm	
Beam (composite) depth, h_2 = h_1 + $insitu_{beam}$	1000	mm	
Cover, $cover_{top2}$ (usually 35 (C35) or 30 (C40) internal; 40 external)	25	mm	
Add cover to hog steel (due to transverse steel layer(s)), $cover_{add,t}$	12	mm	
Hog steel reinforcement diameter, ϕ_{t2}	32	mm	
Hog steel reinforcement number, n_{t2}	8		
Hog steel area provided, $A_{s,hog,prov}$ = $n_{t2}.\pi.\phi_{t2}^2/4$	6434	mm^2	
Number of layers of hog steel, $n_{layers,hog2}$	2	layer(s)	
Spacer for hog steel, $s_{r,hog2}$ (≥ MAX (ϕ_{t2}, 25mm))	32	mm	OK
Eff. depth to sag steel, d_{sag2} = h_2 - $cover_{bot1}$ - ϕ_{link} - [ϕ_{t1}+($n_{layers,sag1}$-1)(ϕ_{t1}+$s_{r,sa}$	917	mm	
Eff. depth to hog steel, d_{hog2} = h_2 - $cover_{top2}$ - MAX(ϕ_{link}, $cover_{add,t}$) - [ϕ_{t2}+(n_{laye}	915	mm	

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.	Rev.
		jXXX	2	
		Member/Location		

Job Title	Structure, Member Design - Precast Concrete Frame, B	Drg. Ref.		
Structure, Member Design - PC Frame, Beam and Slab		Made by XX	Date 30/11/2024	Chd.

BS8110

Detailing Instructions



cover =	25 mm		b_w =	500 mm		$insitu_{slab}$ =	100 mm	
f_{cu} =	55		h_1 =	700 mm		$insitu_{beam}$ =	300 mm	
f_y =	460		h_2 =	1000 mm		nib_b =	0 mm	
f_{yv} =	460					nib_h =	0 mm	

$A_{s,sag,prov}$ =	8 no.	32	rebar in	2	layers @	32 mm	spacer	1.3%
$A_{s,hog,prov}$ =	8 no.	32	rebar in	2	layers @	32 mm	spacer	1.3%
$A_{sv,prov}$ =	4 no.	10	shear link	legs	@	100 mm	pitch	

stage 2 support conditions = **Continuous Internal Span**

precast concrete beam total weight for erection = **8.750** tonnes

strand short-term losses =	5.0	%
strand long-term losses =	15.0	%
strand breaking load =	260.4	kN
strand jacking percentage =	75.0	%

strands =	0	0	0	0	0	0	strands
P_{st} =	0	0	0	0	0	**0**	kN
$-P_{st}/A_1$ =	0.0	0.0	0.0	0.0	0.0	**0.0**	N/mm^2
P_{lt} =	0	0	0	0	0	**0**	kN
$-P_{lt}/A_1$ =	0.0	0.0	0.0	0.0	0.0	**0.0**	N/mm^2
$_{strands,1,b}$ (from bot.) =	50	100	150	200	650	**N/A**	mm
eccentricity, e_s =	-300	-250	-200	-150	300	**N/A**	mm
$M_{PT,st} = \Sigma P_{st}.e_s$ =	0	0	0	0	0	**0**	kNm
$M_{PT,lt} = \Sigma P_{lt}.e_s$ =	0	0	0	0	0	**0**	kNm

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.	Rev.
		jXXX	3	
		Member/Location		
Job Title	Structure, Member Design - Precast Concrete Frame, B	Drg. Ref.		
Structure, Member Design - PC Frame, Beam and Slab		Made by XX	Date 30/11/2024	Chd.

BS8110

Utilisation Summary

Item	UT	Remark
Precast beam sag section ductility	N/A	OK
Precast beam sag steel area provided	41%	OK
Precast beam ultimate shear stress	17%	OK
Precast beam design shear links area	15%	OK
Precast beam design shear resistance	22%	OK
Precast beam deflection	66%	OK
Precast beam deflection (first principles)	28%	OK
Composite beam sag section ductility	N/A	OK
Composite beam sag steel area provided	89%	OK
Composite beam hog section ductility	N/A	OK
Composite beam hog steel area provided	75%	OK
Composite beam ultimate shear stress	40%	OK
Composite beam design shear links area	40%	OK
Composite beam design shear resistance	71%	OK
Composite beam deflection	53%	OK
Composite beam deflection (first principles)	40%	OK
Precast and composite beam miscellaneous checks	N/A	OK

Stage 1 beam bottom section modulus, Z_{b1} **4083** $x10^4$ mm^3

Stage 2 beam bottom section modulus, Z_{b2} **10684** $x10^4$ mm^3

BS8110

Loading and Structural Analysis [Stage 1: Precast Simply-Supported]

British or Eurocode loading combination factors	British	
Beam span, L_1	10.000	m
Tributary width (incoming precast slab clear span), t_{w1}	5.000	m
Dead load of incoming precast slab (pressure load), DL_{slab}	2.50	kPa
Dead load of incoming precast slab insitu topping (pressure load), DL_{top}	2.50	kPa
Note dead load of incoming precast slab insitu topping (pressure load), $DL_{top} = insitu_{slab} \cdot \rho_c$		
SLS slab loading (pressure load), $SLS_{slab1} = DL_{slab} + DL_{top}$	5.00	kPa
Dead load of precast and wet beam (line load), $DL_{beam} = b_{w1}.(\%h_1+insitu_{beam})$	12.5	kN/m
Dead load of precast beam nibs (line load), $DL_{nib} = 2.nib_w.nib_h.\rho_c$	0.0	kN/m
Dead load of precast beam incl. nibs (line load) — 100%	8.8	kN/m
Note dead load of precast beam incl. nibs (line load), $b_{w1}.h_1.\rho_c + DL_{nib}$		
Dead load of incoming precast slab and topping concrete (line load)	28.8	kN/m
Note dead load of incoming precast slab and topping concrete (line load), $b_{w1}.insitu_{beam}.\rho_c + SLS_{slab1}.t_{w1}$		
ULS beam loading (line load), ω_{ULS1}	52.5	kN/m
Note $\omega_{ULS1} = (1.35\text{-}1.4)SLS_{slab1}.t_{w1} + (1.35\text{-}1.4)DL_{beam} + (1.35\text{-}1.4)DL_{nib}$		
Beam unpropped or propped ?	Unpropped	
Beam ULS sag bending moment, $M_{1,sag}$	656	kNm
Note $M_{1,sag} = 0.125.\omega_{ULS1}.L_1^2$ *(if unpropped only)*		
Beam SLS sag bending moment, $M_{1,sag,SLS}$	469	kNm
Note $M_{1,sag,SLS}$ *calculated as per* $M_{1,sag}$ *but without load combination factors, plus the addition of* $M_{PT,lt}$.		
Beam bottom SLS stress at end of stage 1 (comp. -ve), $\sigma_{b1,SLS}$	11.48	N/mm^2
Note $\sigma_{b1,SLS} = -\Sigma P_{lt}/A_1 + M_{1,sag,SLS}/Z_{b1}$		
Note beam bottom stress at end of stage 1 results from prestressing, dead load of precast beam including nibs and dead load of precast slab and topping concrete.		
Beam ULS shear force, $V_1 = 0.5.\omega_{ULS1}.L_1$ (if unpropped only)	263	kN

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.	Rev.
		jXXX	4	
		Member/Location		
Job Title	Structure, Member Design - Precast Concrete Frame, B	Drg. Ref.		
Structure, Member Design - PC Frame, Beam and Slab		Made by XX	Date 30/11/2024	Chd.

BS8110

Loading and Structural Analysis [Stage 2: Insitu]

British or Eurocode loading combination factors — British

Beam span, L_2	10.000	m
Tributary width (grid to grid), t_{w2}	5.000	m
Superimposed dead load on slab (pressure load), SDL_{slab}	15.00	kPa
Superimposed dead load on beam (line load), SDL_{beam}	0.0	kN/m
Superimposed dead load on beam (midspan point load), SDL_{point}	0.0	kN
Live load on slab (pressure load), LL_{slab} [with pattern loading]	10.00	kPa
Superimposed dead and live load on beam (line load), $[SDL_{slab} + LL_{slab}].t_{w2}$ +	125.0	kN/m
ULS beam loading (line load), ω_{ULS2}	185.0	kN/m

Note $\omega_{ULS2} = ((1.35\text{-}1.4)SDL_{slab} + (1.5\text{-}1.6)LL_{slab}).t_{w2} + (1.35\text{-}1.4)SDL_{beam}$

Beam ULS sag bending moment, $M_{2,sag}$ — Continuous Internal Span — **1171** kNm

Note $M_{2,sag} = k_{DL|SDL,sag}.\,\omega_{ULS1}.L_2^{\,2}$ (if propped only) $+ k_{DL|SDL,sag}.(1.35\text{-}1.4).[SDL_{slab}.t_{w2} + SDL_{beam}].L_2^{\,2}$
$+ k_{SDL,p,sag}.(1.35\text{-}1.4).[SDL_{point}].L_2 + k_{LL,sag}.(1.5\text{-}1.6).[LL_{slab}.t_{w2}].L_2^{\,2}$

	$k_{DL\|SDL,sag}$	$k_{SDL,p,sag}$	$k_{LL,sag}$
Continuous Internal Span	0.046	0.125	0.086
Continuous End Span	0.078	0.170	0.100
Simply-Supported	0.125	0.250	0.125

Beam SLS sag bending moment, $M_{2,sag,SLS}$ — **775** kNm

Note $M_{2,sag,SLS}$ calculated as per $M_{2,sag}$ but without load combination factors.

Beam bottom SLS stress stage 2 loading (comp. -ve), $\sigma_{b2,SLS}$ — **7.25** N/mm^2

Note $\sigma_{b2,SLS} = M_{2,sag,SLS}/Z_{b2}$

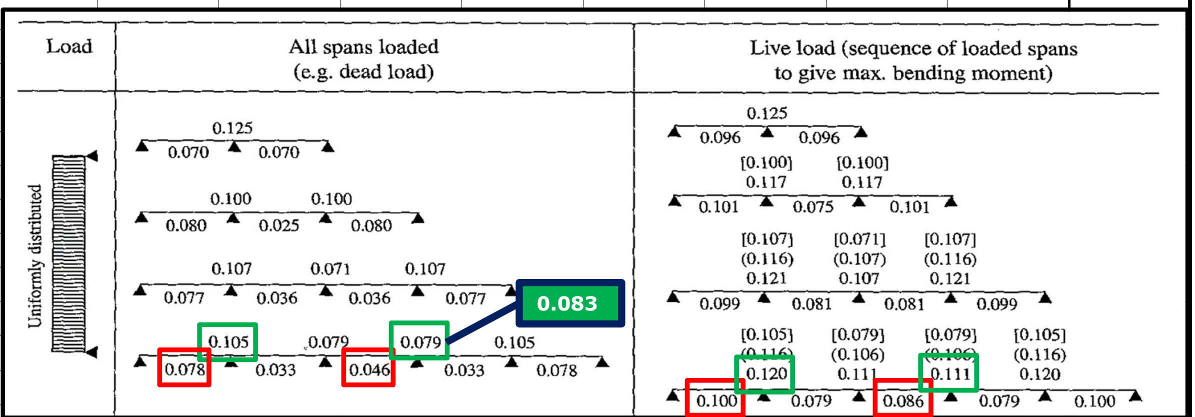
Beam bottom SLS stress at end of stage 2 (comp. -ve), $\sigma_{b1,SLS} + \sigma_{b2,SLS}$ — **18.73** N/mm^2

Beam total ULS sag bending moment, $M_{1,sag} + M_{2,sag}$ — **1827** kNm

Beam ULS hog bending moment, $M_{2,hog}$ — Continuous Internal Span — **1760** kNm

Note $M_{2,hog} = k_{DL|SDL,hog}.\,\omega_{ULS1}.L_2^{\,2}$ (if propped only) $+ k_{DL|SDL,hog}.(1.35\text{-}1.4).[SDL_{slab}.t_{w2} + SDL_{beam}].L_2^{\,2}$
$+ k_{SDL,p,hog}.(1.35\text{-}1.4).[SDL_{point}].L_2 + k_{LL,hog}.(1.5\text{-}1.6).[LL_{slab}.t_{w2}].L_2^{\,2}$

	$k_{DL\|SDL,hog}$	$k_{SDL,p,hog}$	$k_{LL,hog}$
Continuous Internal Span	0.083	0.125	0.111
Continuous End Span	0.105	0.161	0.120
Simply-Supported	0.040	0.040	0.040



Beam ULS shear force, V_2 — **925** kN

Note $V_2 = (0.5\text{-}0.6).\,\omega_{ULS1}.L_2$ (if propped only) $+ (0.5\text{-}0.6).\,\omega_{ULS2}.L_2 + (0.5\text{-}0.6).((1.35\text{-}1.4)SDL_{point})$

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.	Rev.
		jXXX	5	
		Member/Location		
Job Title	Structure, Member Design - Precast Concrete Frame, B	Drg. Ref.		
Structure, Member Design - PC Frame, Beam and Slab		Made by XX	Date 30/11/2024	Chd.

BS8110

Structural Design [Stage 1: Precast Simply-Supported]

Bending Design

Stress coefficient, $M_{1,sag}/b_{w1}d_{sag1}^2$	**3.4**	N/mm^2	
Stress coefficient, $K_{sag1} = M_{1,sag}/b_{w1}d_{sag1}^2f_{cu}$	**0.063**		**OK**
Lever arm, $z_{sag1} = d_{sag1}.[0.5+(0.25-K_{sag1}/0.9)^{0.5}] \leq 0.95d_{sag1}$	**571**	mm	
Area of req. sag steel, $A_{s,sag1} = M_{1,sag} / (0.95f_y.z_{sag1})$	**2632**	mm^2	
Sag steel area provided, $A_{s,sag,prov}$	6434	mm^2	
Sag steel area provided utilisation, $A_{s,sag1} / A_{s,sag,prov}$	**41%**		**OK**

Shear Design

Ultimate shear stress, $v_{ult1} = V_1/b_{w1}d_{sag1}$ (< $0.8f_{cu}^{0.5}$ & $5.0N/mm^2$)		**0.85**	N/mm^2	
Ultimate shear stress utilisation, v_{ult1} / ($0.8f_{cu}^{0.5}$ & $5.0N/mm^2$)		**17%**		**OK**
Design shear stress, $v_{d1} = V_1/b_{w1}d_{sag1}$		**0.85**	N/mm^2	
Enhanced shear strength, $2d_{sag1}/a_v.v_c$ (< $0.8f_{cu}^{0.5}$ & $5.0N/mm^2$)	*x 1.00*	**1.05**	N/mm^2	
Distance, a_v	2.00d	1234	mm	

(Shear capacity enhancement by calculating v_d within 2d of support and comparing against enhanced v_c within 2d of the support as clause 3.4.5.8 BS8110 employed instead of calculating v_d at d from support and comparing against unenhanced v_c as clause 3.4.5.10 BS8110;)

Sag steel area provided, $A_{s,sag,prov}$	6434	mm^2	
$\rho_w = 100A_{s,sag,prov}/b_{w1}d_{sag1}$	2.09	%	
$v_c = (0.79/1.25)(\rho_w f_{cu}/25)^{1/3}(400/d_{sag1})^{1/4}$; $\rho_w<3$; $f_{cu}<80$; $(400/d_{sag}$	**1.05**	N/mm^2	
Provide shear links $(A_{sv}/S)_1 > b_{w1}MAX[0.4,(v_{d1}-2d_{sag1}/a_v.v_c)]/(0.95f_{yv})$ i.e. $(A_{sv}$	**0.46**	mm^2/mm	
Area provided by all shear links in a cross-section, $A_{sv,prov}/S$	**3.14**	mm^2/mm	
Concrete and design links shear capacity, $V_{cap1} = (A_{sv,prov}/S).(0.95f_{yv}).d_{sag1}$ +	**1171**	kN	
Design shear links area utilisation, $(A_{sv}/S)_1 / (A_{sv,prov}/S)$	**15%**		**OK**
Design shear resistance utilisation, V_1 / V_{cap1}	**22%**		**OK**

Deflection Design

Span	10.000	m	
Span / effective depth ratio	**16.2**		
Basic span / effective depth ratio criteria	**20.0**		
Multiplier $C_{1,rect\ or\ flanged}$	1.00		cl.3.4.6.3
Multiplier $C_{1,span\ more\ or\ less\ than\ 10m}$ (Include)	1.00		cl.3.4.6.4
Modification factor for tension C_2	**1.22**		T.3.10
$(M_{1,sag}+M_{PT,lt})/b_{w1}.d_{sag1}^2$	3.45	N/mm^2	cl.3.4.6.2
f_s	125	N/mm^2	
Modified span / effective depth ratio criteria	**24.5**		
Deflection utilisation	**66%**		**OK**

$$0.55 + \frac{(477 - f_s)}{120\left(0.9 + \frac{M}{bd^2}\right)} \leq 2.0$$

$$f_s = \frac{2f_y A_{s\ req}}{3A_{s\ prov}} \times \frac{1}{\beta_b}$$

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.	Rev.
		jXXX	6	
		Member/Location		
Job Title	Structure, Member Design - Precast Concrete Frame, B	Drg. Ref.		
Structure, Member Design - PC Frame, Beam and Slab		Made by XX	Date 30/11/2024	Chd.

BS8110

Structural Design [Stage 2: Insitu]

Bending Design

Stress coefficient, $M_{2,sag}/b_{w2}d_{sag2}^2$		2.8	N/mm^2	
Stress coefficient, $M_{1,sag}/b_{w1}d_{sag1}^2 + M_{2,sag}/b_{w2}d_{sag2}^2$		6.2	N/mm^2	
Stress coefficient, $K_{sag2} = M_{2,sag}/b_{w2}d_{sag2}^2f_{cu}$		0.051		OK
Lever arm, $z_{sag2} = d_{sag2}.[0.5+(0.25-K_{sag2}/0.9)^{0.5}] \leq 0.95d_{sag2}$		862	mm	
Area of req. sag steel, $A_{s,sag2} = M_{2,sag} / (0.95f_y.z_{sag2})$		3108	mm^2	
Sag steel area provided, $A_{s,sag,prov}$		6434	mm^2	
Sag steel area provided utilisation, $[A_{s,sag1} + A_{s,sag2}] / A_{s,sag,prov}$		89%		OK
Stress coefficient, $M_{2,hog}/b_{w2}d_{hog2}^2$		4.2	N/mm^2	
Stress coefficient, $K_{hog2} = M_{2,hog}/b_{w2}d_{hog2}^2f_{cu}$		0.076		OK
Lever arm, $z_{hog2} = d_{hog2}.[0.5+(0.25-K_{hog2}/0.9)^{0.5}] \leq 0.95d_{hog2}$		829	mm	
Area of req. hog steel, $A_{s,hog2} = M_{2,hog} / (0.95f_y.z_{hog2})$		4855	mm^2	
Hog steel area provided, $A_{s,hog,prov}$		6434	mm^2	
Hog steel area provided utilisation, $A_{s,hog2} / A_{s,hog,prov}$		75%		OK

Shear Design

Ultimate shear stress, $v_{ult2} = V_2/b_{w2}d_{hog2}$ ($< 0.8f_{cu}^{0.5}$ & $5.0N/mm^2$)		2.02	N/mm^2	
Ultimate shear stress utilisation, v_{ult2} / ($0.8f_{cu}^{0.5}$ & $5.0N/mm^2$)		40%		OK
Design shear stress, $v_{d2} = V_2/b_{w2}d_{hog2}$		2.02	N/mm^2	
Enhanced shear strength, $2d_{hog2}/a_v.v_c$ ($< 0.8f_{cu}^{0.5}$ & $5.0N/mm^2$)	*x 1.00*	0.92	N/mm^2	
Distance, a_v	2.00d	1830	mm	

(Shear capacity enhancement by calculating v_d within 2d of support and comparing against enhanced v_c within 2d of the support as clause 3.4.5.8 BS8110 employed instead of calculating v_d at d from support and comparing against unenhanced v_c as clause 3.4.5.10 BS8110;)

Hog steel area provided, $A_{s,hog,prov}$		6434	mm^2	
$\rho_w = 100A_{s,hog,prov}/b_{w2}d_{hog2}$		1.41	%	
$v_c = (0.79/1.25)(\rho_w f_{cu}/25)^{1/3}(400/d_{hog2})^{1/4}$; $\rho_w<3$; $f_{cu}<80$; $(400/d_{ho}$		0.92	N/mm^2	
Provide shear links $(A_{sv}/S)_2 > b_{w2}MAX[0.4,(v_{d2}-2d_{hog2}/a_v.v_c)]/(0.95f_{yv})$ i.e. $(A_{sv}$		1.26	mm^2/mm	
Area provided by all shear links in a cross-section, $A_{sv,prov}/S$		3.14	mm^2/mm	
Concrete and design links shear capacity, $V_{cap2} = (A_{sv,prov}/S).(0.95f_{yv}).d_{hog2}$ +		1678	kN	
Design shear links area utilisation, $[(A_{sv}/S)_1 + (A_{sv}/S)_2] / (A_{sv,prov}/S)$		40%		OK
Design shear resistance utilisation, $[V_1 + V_2] / V_{cap2}$		71%		OK

Deflection Design

Span		10.000	m	
Span / effective depth ratio		10.9		
Basic span / effective depth ratio criteria	Continuous Internal Span	26.0		
Multiplier $C_{1,rect\ or\ flanged}$		1.00		*cl.3.4.6.3*
Multiplier $C_{1,span\ more\ or\ less\ than\ 10m}$	Include	1.00		*cl.3.4.6.4*
Modification factor for tension C_2	$0.55 + \frac{(477 - f_s)}{120\left(0.9 + \frac{M}{bd^2}\right)} \leq 2.0$	0.79		*T.3.10*
$(M_{1,sag}+M_{PT,lt})/b_{w1}d_{sag1}^2 + M_{2,sag}/b_{w2}d_{sag2}$		6.23	N/mm^2	*cl.3.4.6.2*
$f_s = \frac{2f_y A_{s\ req}}{3A_{s\ prov}} \times \frac{1}{\beta_b}$		274	N/mm^2	
Modified span / effective depth ratio criteria		20.5		
Deflection utilisation		53%		OK

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.: jXXX	Sheet No.: 7	Rev.
		Member/Location		
Job Title	Structure, Member Design - Precast Concrete Frame, B	Drg. Ref.		
Structure, Member Design - PC Frame, Beam and Slab		Made by XX	Date 30/11/2024	Chd.

BS8110

Deflection Design Based on First Principles

Code of practice adopted for calculation of elastic modulus, E	BS8110		
Creep modulus factor, C_{MF}	Storage Loading, CMF=1/[1+f=2.0]		
Uncracked short-term, $E_{uncracked,28}$		**31.0**	GPa
Uncracked long-term (creep), $E_{uncracked,28,cp}$ = C_{MF} . $E_{uncracked,28}$		**10.3**	GPa
Cracked short-term, E_{ck} = $E_{uncracked,28}$. [0.5-1.0]	0% Cracking	**31.0**	GPa
Cracked long-term (creep), $E_{ck,cp}$ = $E_{uncracked,28,cp}$. [0.5-1.0]		**10.3**	GPa

Structural Design [Stage 1: Precast Simply-Supported]

Beam (precast) width, b_{w1} = b_w		500	mm	
Beam (precast) depth, h_1		700	mm	
Beam (precast) area, A_1 = $b_{w1}.h_1+2.nib_b.nib_h$		3500	cm^2	
Beam (precast) centroid, x_{c1} = $(b_{w1}.h_1^2/2+2.nib_b.nib_h^2/2)/A_1$		350	mm	
Beam (precast) inertia, I_1		**1429**	$x10^3$ cm^4	
Note $I_1 = (b_{w1}.h_1^3+2.nib_b.nib_h^3)/12+b_{w1}.h_1.(x_{c1}-h_1/2)^2+2.nib_b.nib_h.(x_{c1}-nib_h/2)^2$				
Beam (precast) bottom section modulus, Z_{b1} = I_1/x_{c1}		**4083**	$x10^4$ mm^3	
SLS beam loading (line load), ω_{SLS1}		**37.5**	kN/m	
Note $\omega_{SLS1} = SLS_{slab1}.t_{w1}+DL_{beam}+DL_{nib}$				
Beam (precast) deflections, δ_1	Unpropped	**11.0**	mm	
Note $\delta_1 = 5\,\omega_{SLS1}.L_1^4/[384E_{ck}.I_1]$ (if unpropped only) + $M_{PT,lt}.L_1^2/[8E_{ck}.I_1]$				
Beam (precast) deflections criteria, $L_1/250$		**40.0**	mm	
Beam (precast) deflections utilisation, $\delta_1/[L_1/250]$		**28%**		**OK**

Structural Design [Stage 2: Insitu]

Beam (composite) width, b_{w2} = b_w		500	mm	
Beam (composite) depth, h_2		1000	mm	
Beam (composite) flange eff. width, b_{eff2} = $b_{w2}+L_2$/{5.00 s/s, 7.14 cont.}		1901	mm	
Beam (composite) flange thickness, h_f = $insitu_{slab}$		100	mm	
Beam (composite) area, A_{eff2} = $h_2.b_{w2}+(b_{eff2}-b_{w2}).h_f+2.nib_b.nib_h$		6401	cm^2	
Beam (composite) centroid, x_{c2} = $h_2-((b_{eff2}.h_f).(h_2-h_f/2)+b_{w2}.(h_2-h_f)^2/2+2.nib_t$		402	mm	
Beam (composite) inertia, I_2		**6394**	$x10^3$ cm^4	
Note $I_2 = (b_{eff2}.h_f^3+b_{w2}.(h_2-h_f)^3+2.nib_b.nib_h^3)/12+b_{eff2}.h_f.(x_{c2}-h_f/2)^2+b_{w2}.(h_2-h_f).((h_2-x_{c2})-(h_2-h$				
Beam (composite) effect of composite and flanged section, $[I_2/I_1]$		**4.47**		
Beam (composite) bottom section modulus, Z_{b2} = $I_2/(h_2-x_{c2})$		**10684**	$x10^4$ mm^3	
SLS beam loading (line load), ω_{SLS1} (if propped only) +	Unpropped	**125.0**	kN/m	
Note $\omega_{SLS2} = (SDL_{slab}+LL_{slab}).t_{w2}+SDL_{beam}$				
SLS beam loading (midspan point load), P_{SLS2} = SDL_{point}		**0.0**	kN	
Beam (composite) deflections, δ_2	Continuous Internal Span	**4.9**	mm	
Note $\delta_2 = \omega_{SLS2}.L_1^4/[384E_{ck,cp}.I_2] + P_{SLS2}.L_2^3/[192E_{ck,cp}.I_2]$ continuous internal span				
Note $\delta_2 = \omega_{SLS2}.L_1^4/[185E_{ck,cp}.I_2] + P_{SLS2}.L_2^3/[107E_{ck,cp}.I_2]$ continuous end span				
Note $\delta_2 = 5\,\omega_{SLS2}.L_1^4/[384E_{ck,cp}.I_2] + P_{SLS2}.L_2^3/[48E_{ck,cp}.I_2]$ simply-supported				
Beam (composite) incremental deflections criteria, MIN{20mm,$L_2/500$}		**20.0**	mm	
Beam (composite) incremental deflections utilisation, δ_2/MIN{20mm,$L_2/500$}		**25%**		**OK**
Beam (composite) total deflections criteria, $L_2/250$		**40.0**	mm	
Beam (composite) total deflections utilisation, $(\delta_1+\delta_2)/[L_2/250]$		**40%**		**OK**