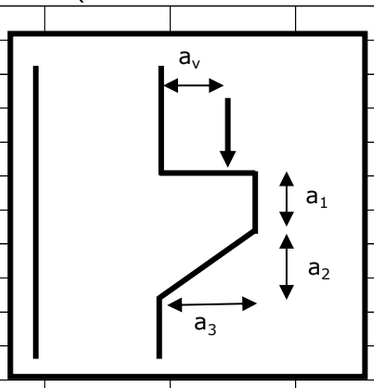
CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
		jXXX	1		
		Member/Location			
Job Title	Member Design - Reinforced Concrete Corbel BS8110, E	Drg. Ref.			
Member Design - RC Corbel		Made by XX	Date 5/11/2026		Chd.

Material Properties

Characteristic strength of concrete, f_{cu} / f_{ck} | f_c' (f_{cu} ≤ 60N/mm^2; HS	60	50	N/mm^2	**OK**
Yield strength of longitudinal steel, f_y	Higher	500	N/mm^2	
Yield strength of shear link steel, f_{yv}	Higher	500	N/mm^2	
Elastic modulus of steel, E_s		200000	N/mm^2	
Ultimate strain of concrete, ε_{cc}		0.0035		

Dimensions

Corbel or nib (affects criteria for no shear links at low shear stresses)		Corbel		



Width, b		1150	mm	
Dimension, a_1 (>= 0.5h cl.5.2.7.1(b) BS8110 | >= 0.5d cl.16.5.2.2 ACI318)		400	mm	**NOT OK**
Dimension, a_2		500	mm	
Dimension, a_3		400	mm	
Actual distance of centreline of applied load from face of column, a_c		200	mm	
Stiff bearing or flexible bearing ?	Flexible bearing			
Distance of centreline of applied load from face of column, a_v		**200**	mm	
(Note a_v should be taken as a_3 for stiff bearing and a_c for flexible bearing)				
Overall depth, h = a_1 + a_2		900	mm	
Effective depth to tensile steel, d = a_1 + a_2 - cover - ϕ_{link} - ϕ_t/2		841	mm	
Shear span to depth ratio, a_v/h		**0.22**		**OK**
Shear span to depth ratio, a_v/d		**0.24**		**OK**

Limit for vertical links (VL), 1.00 < $(a_v/d)_{limit}$ ≤ 2.00	**Not Applicable**		*cl.3.4.5.8 BS8*
Limit for horizontal links (HL), $(a_v/d)_{limit}$ ≤ 1.00	**Horizontal Links**		*cl.3.4.5.9, cl.5.2.7.1*
Limit for vertical links (VL), 0.50 < $(a_v/h)_{limit}$ | $(a_v/d)_{limit}$ ≤ 2.00	**Not Applicable**		*cl.6.2.3(8), cl.J.3(*
Limit for horizontal links (HL), $(a_v/h)_{limit}$ ≤ 0.50	**Horizontal Links**		*cl.J.3(2) EC*
Limit for vertical links (VL), 1.00 < $(a_v/d)_{limit}$ ≤ 2.00	**Not Applicable**		
Limit for horizontal links(HL), $(a_v/d)_{limit}$ ≤ 1.00	**Horizontal Links**		*cl.16.5.1.1 ACI*

Reinforcement

Cover to all reinforcement, cover (usually 35 (C35) or 30 (C40) internal; 40 e		35	mm	
Tension steel reinforcement diameter, ϕ_t (>= 10mm)		25	mm	**OK**
Tension steel reinforcement number, n_t		8		
Tension steel area provided, $A_{s,prov,t}$ = $n_t.\pi.\phi_t^2/4$		**3927**	mm^2	
Shear link diameter, ϕ_{link}		12	mm	
Number of links in a cross section, i.e. number of legs, n_{leg}		4		
Number of cross sections of links within a_v (VL) or d (HL), n_{sec}		5		
Area provided by all links within a_v (VL) or d (HL), $A_{sv,prov}$ = $\pi.\phi_{link}^2/4.n_{leg}.n_{sec}$		**2262**	mm^2	

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		jXXX	2		
		Member/Location			
Job Title	Member Design - Reinforced Concrete Corbel BS8110, E	Drg. Ref.			
Member Design - RC Corbel		Made by XX	Date 5/11/2026		Chd.

Loading

ULS applied load, V_d	2039	1935	1914	kN
Applied load, $V_{G=DL+SDL}$			623	kN
Applied load, $V_{Q=LL}$			729	kN

DL+SDL [G] and LL [Q] factors for ULS, k_G and k_Q		k_G	k_Q		
British Standards [BS8110-1:1997]		*1.40*	*1.60*		*cl.2.4.3.1.1*
European Standards [EN1990:2002]		*1.35*	*1.50*		*cl.6.4.3.2*
American Standards [ACI318-19]		*1.20*	*1.60*		*cl.5.3.1*

Executive Summary

Item				UT	Remark
Bearing stress utilisation	20%	41%	17%	41%	OK
Tension reinforcement utilisation	55%	68%	100%	100%	OK
Ultimate shear stress utilisation	42%	28%	45%	45%	OK
Design shear resistance utilisation	71%	59%	96%	96%	OK
Min tension steel reinforcement pitch utilisation	51%	51%	51%	51%	OK
% Min tension reinforcement utilisation	34%	52%	98%	98%	OK
% Max tension reinforcement utilisation	9%	9%	9%	9%	OK
% Min shear reinforcement utilisation	32%	21%	32%	32%	OK
% Min combined tension and shear reinforcement utilisa	25%	33%	71%	71%	OK
% Max combined tension and shear reinforcement utilis	15%	15%	15%	15%	OK
Total utilisation				**100%**	**OK**

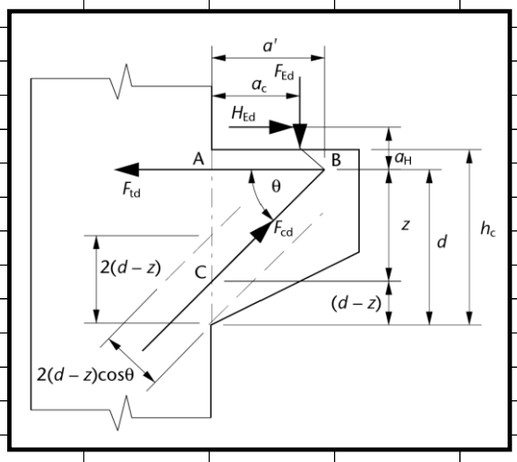
110
BS8110
3) EC2
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318

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
		jXXX	3		
		Member/Location			
Job Title	Member Design - Reinforced Concrete Corbel BS8110, E	Drg. Ref.			
Member Design - RC Corbel		Made by XX	Date 5/11/2026		Chd.

			BS8110
Bearing Stress Limit (BS8110)			*Mosley*
Bearing area, A = b.(a_3-r)	4,198	cm^2	
Reduction of dimension a_3 due to chamfer and gap, r	35	mm	
Bearing stress, $\sigma = V_d/A$	4.9	N/mm^2	
Bearing stress limit, $\sigma_{lim} = 0.4f_{cu}$	24.0	N/mm^2	*cl.5.2.3.4*
Bearing stress utilisation, σ/σ_{lim}	**20%**		**OK**
Tension Reinforcement Design (BS8110)			*Mosley*
Tension force, $F_t = V_d.a_v/z$ (>= $0.5V_d$)	**1019**	kN	*cl.5.2.7.2.1*
Parameter, $k = V_d/(0.9f_{cu}.b.a_v)$	0.16		
Lever arm, $z = d.(0.5+\sqrt{(0.25-(1+k).k.a_v^2/d^2)})/(1+k)$	714	mm	
Depth to neutral axis, x = (d-z)/0.45	281	mm	
Ratio x/d	0.334		
Tension steel yielded or not ?	Yielded		
(Note if x/d > $\varepsilon_{cc}/(\varepsilon_{cc}+0.95f_y/E_s)$, tension steel not yielded; and vice versa)			
Steel stress, f_{st}	475	N/mm^2	
(Note if not yielded, $f_{st} = E_s.\varepsilon_{cc}(d-x)/x$; else $f_{st} = 0.95f_y$)			
Tension steel, $A_s = F_t/f_{st}$	**2146**	mm^2	
Tension steel area provided, $A_{s,prov,t}$	3927	mm^2	
Tension steel area provided utilisation = A_s / $A_{s,prov,t}$	**55%**		**OK**
% Min tension reinforcement = 0.0013bh	1346	mm^2	*cl.3.12.5.3*
% Min tension reinforcement utilisation	**34%**		**OK**
% Max tension reinforcement = 0.04bh	41400	mm^2	*cl.3.12.6.1*
% Max tension reinforcement utilisation	**9%**		**OK**
Tension reinforcement pitch = (b - 2.cover - $2\phi_{link}$ - ϕ_t)/(n_t-1)	147	mm	
Min tension steel reinforcement pitch utilisation (>75mm, >100mm if T40)	**51%**		**OK**
(Note no allowance has been made for laps in the min pitch as not deemed to be required)			

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
		jXXX	4		
		Member/Location			
Job Title	Member Design - Reinforced Concrete Corbel BS8110, E	Drg. Ref.			
Member Design - RC Corbel		Made by **XX**	Date **5/11/2026**		Chd.

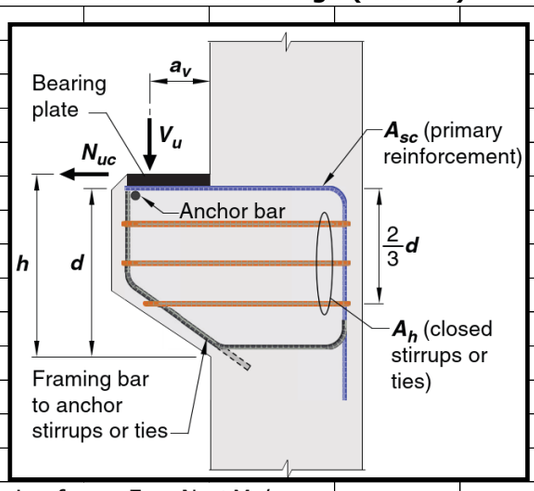
										EC2
Bearing Stress Limit (EC2)										*Mosley*
Bearing area, A = b.(a_3-r)								4,198	cm^2	
	Reduction of dimension a_3 due to chamfer and gap, r							35	mm	
Bearing stress, $\sigma = V_d/A$								4.6	N/mm^2	
Bearing stress limit, $\sigma_{lim} = 0.4f_{cd} = 0.4\alpha_{cc}.f_{ck}/\gamma_c$								11.3	N/mm^2	*.10.9.5.2(2*
Bearing stress utilisation, σ/σ_{lim}								**41%**		**OK**
Tension Reinforcement Design (EC2)										*Mosley*

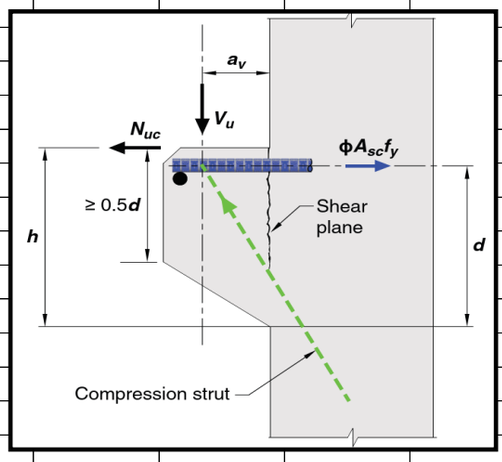


Tension force, $F_t = V_d.(\cot\theta+0.2)$						**Corbel**		**1169**	kN	
	Bearing thickness							5	mm	
	Distance, a_H = bearing thickness + cover + ϕ_{link} + $\phi_t/2$							65	mm	
	Distance, a' = a_v+0.2a_H							213	mm	
	Design compressive strength limit, $f_{cd} \le (\alpha_{cc}.f_{ck}/\gamma_c).\nu_1$							13.6	N/mm^2	
		α_{cc} = 0.85						0.85		
		γ_c = 1.5						1.5		
		ν_1 = 0.6(1-f_{ck}/250)						0.48		
		k = a'/d						0.25		
		D = $V_d/[f_{cd}.bd]$						0.15		
	Angle comp. strut, $\theta=0.5[\pi-\sin^{-1}((D+k)/\sqrt{(1+k^2)})-\tan^{-1}(k)]$							71.5	°	
	Angle of comp. strut limits, θ						$68^\circ \ge \theta \ge 45^\circ$	**68.0**	°	
	Check	$\frac{F_{Ed}}{f_{cd}\,d\,b_w} - \left(1 - \left[\frac{a'}{d}\right]\tan\theta\right)\sin 2\theta \le 0$						-0.112		**OK**
Tension steel, $A_s = F_t/(0.87f_y)$								**2686**	mm^2	
Tension force, $F_t = M/z+0.2V_d$						**Not Applicable**		**903**	kN	
	Moment, $M = V_d.a'$							412	kNm	
	Stress coeff., $K = M/bd^2f_{ck} \le 0.167$ [$f_{ck} \le 50N/mm^2$]							0.010		**OK**
	Lever arm, $z = d.[0.5+(0.25-K/1.134)^{0.5}] \le 0.95d$							798	mm	
Tension steel, $A_s = F_t/(0.87f_y)$								**2075**	mm^2	
Tension steel area provided, $A_{s,prov,t}$								3927	mm^2	
Tension steel area provided utilisation = A_s / $A_{s,prov,t}$								**68%**		**OK**
% Min tension reinforcement = MAX(0.0013, 0.26(f_{ctm}/f_y)).bd								2046	mm^2	*l.9.2.1.1(1*
% Min tension reinforcement utilisation								**52%**		**OK**
% Max tension reinforcement = 0.04bh								41400	mm^2	*l.9.2.1.1(3*
% Max tension reinforcement utilisation								**9%**		**OK**
Tension reinforcement pitch = (b - 2.cover - 2ϕ_{link} - ϕ_t)/(n_t-1)								147	mm	
Min tension steel reinforcement pitch utilisation (>75mm, >100mm if T40)								**51%**		**OK**
(Note no allowance has been made for laps in the min pitch as not deemed to be required)										

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
		jXXX	5		
		Member/Location			
Job Title	Member Design - Reinforced Concrete Corbel BS8110, E	Drg. Ref.			
Member Design - RC Corbel		Made by XX	Date 5/11/2026		Chd.

			ACI318
Bearing Stress Limit (ACI318)			
Bearing area, A = b.(a_3-r)	4,198	cm^2	
Reduction of dimension a_3 due to chamfer and gap, r	35	mm	
Bearing stress, $\sigma = V_d/A$	4.6	N/mm^2	
Bearing stress limit, $\sigma_{lim} = \phi 0.85 f_c' = 0.65(0.85 f_c')$	27.6	N/mm^2	*cl.22.8.3.2,*
Bearing stress utilisation, σ/σ_{lim}	**17%**		**OK**
Tension Reinforcement Design (ACI318)			*cl.16.5*





Tension force, $F_t = N_{uc} + M_u/z$	**869**	kN	*cl.16.5.4.3,*
Restraint force, N_{uc} = MAX(0.2V_d, 0.2.(1.6).V_G)	383	kN	*3.2, cl.16.2*
Moment, $M_u = V_d.a_v + N_{uc}.(h-d)$	406	kNm	*cl.16.5.3.1*
Stress block, $a = d - \sqrt{(d^2 - 2M_u/(\phi 0.85 f_c'.b))}$, ϕ=0.75	13	mm	*.2.2.4.1, T.*
Lever arm, z = d-a/2	834	mm	*cl.22.2*
$A_n = N_{uc}/(\phi.f_y)$ ϕ=0.75, $f_y \leq 550 N/mm^2$	1021	mm^2	*cl.16.5.4.3*
$A_{vf} = V_d/(\phi.\mu.f_y)$ ϕ=0.75, μ=1.4λ, $f_y \leq 420 N/mm^2$	4340	mm^2	*5.4.4, cl.22*
where λ = {1.00 NWC, 0.75 LWC}	Normal weight		
Tension steel, A_s = MAX{$F_t/(\phi f_y)$,2/3.A_{vf}+A_n,0.04(f_c'/f_y).bd} ϕ=0.75, $f_y \leq 550 N/$	**3914**	mm^2	*.16.5.5.1(b*
Tensile steel area provided, $A_{s,prov,t}$	3927	mm^2	
Tension steel area provided utilisation = A_s / $A_{s,prov,t}$	**100%**		**OK**
% Min tension reinforcement = 0.04(f_c'/f_y).bd	3866	mm^2	*.16.5.5.1(c*
% Min tension reinforcement utilisation	**98%**		**OK**
% Max tension reinforcement = 0.04bh	41400	mm^2	*N/A*
% Max tension reinforcement utilisation	**9%**		**OK**
Tension reinforcement pitch = (b - 2.cover - 2ϕ_{link} - ϕ_t)/(n_t-1)	147	mm	
Min tension steel reinforcement pitch utilisation (>75mm, >100mm if T40)	**51%**		**OK**

(Note no allowance has been made for laps in the min pitch as not deemed to be required)

CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
		jXXX	6		
		Member/Location			
Job Title	Member Design - Reinforced Concrete Corbel BS8110, E	Drg. Ref.			
Member Design - RC Corbel		Made by XX	Date 5/11/2026		Chd.

					BS8110
Shear Reinforcement Design (BS8110)					
Ultimate shear stress, $v_{ult} = V_d/bd$ (< $0.8f_{cu}^{0.5}$ & 5.0N/mm^2)			**2.11**	N/mm^2	*cl.3.4.5.8*
Ultimate shear strength, MIN{$0.8f_{cu}^{0.5}$ & 5.0N/mm^2}			**5.00**	N/mm^2	*cl.3.4.5.8*
Ultimate shear stress utilisation			**42%**		**OK**
T.21.2.1(d)					
Design shear stress, $v_d = V_d/bd$			**2.11**	N/mm^2	
Enhanced shear strength, $2d/a_v.v_c$ (< $0.8f_{cu}^{0.5}$ & 5.0N/mm^2)		*x 4.00*	**1.82**	N/mm^2	*cl.3.4.5.8*
Distance, a_v			200	mm	
(Shear capacity enhancement by calculating v_d at support and comparing against enhanced v_c within					
2d of the support as cl.3.4.5.8 BS8110 ***employed****, that of cl.3.4.5.10 BS8110* ***not applicable****;)*					
Area of tensile steel reinforcement provided, $A_{s,prov,t}$			3927	mm^2	
$\rho_w = 100A_{s,prov,t}/bd$			0.41	%	
$v_c = (0.79/1.25)(\rho_w f_{cu}/25)^{1/3}(400/d)^{1/4}$			**0.45**	N/mm^2	*cl.3.4.5.4*
$\rho_w = 100A_{s,prov,t}/bd \le 3$			0.41	%	*cl.3.4.5.4*
$f_{cu} = f_{cu} \le 40$N/mm^2			40	N/mm^2	
$(400/d)^{1/4} \ge 0.67$			0.83		*cl.3.4.5.4*

Table 3.8 — Values of v_c design concrete shear stress

$\frac{100A_s}{b_v d}$	Effective depth mm							
	125	150	175	200	225	250	300	400
	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
≤ 0.15	0.45	0.43	0.41	0.40	0.39	0.38	0.36	0.34
0.25	0.53	0.51	0.49	0.47	0.46	0.45	0.43	0.40
0.50	0.67	0.64	0.62	0.60	0.58	0.56	0.54	0.50
0.75	0.77	0.73	0.71	0.68	0.66	0.65	0.62	0.57
1.00	0.84	0.81	0.78	0.75	0.73	0.71	0.68	0.63
1.50	0.97	0.92	0.89	0.86	0.83	0.81	0.78	0.72
2.00	1.06	1.02	0.98	0.95	0.92	0.89	0.86	0.80
≥ 3.00	1.22	1.16	1.12	1.08	1.05	1.02	0.98	0.91

NOTE 1 Allowance has been made in these figures for a γ_m of 1.25.

NOTE 2 The values in the table are derived from the expression:

$0.79(100A_s/(b_v d))^{1/3}(400/d)^{1/4}/\gamma_m$

where

$\frac{100A_s}{b_v d}$ should not be taken as greater than 3;

$\left(\frac{400}{d}\right)^{\frac{1}{4}}$ should not be taken as less than 0.67 for members without shear reinforcement;

$\left(\frac{400}{d}\right)^{\frac{1}{4}}$ should not be taken as less than 1 for members with shear reinforcement providing a design shear resistance of ≥ 0.4 N/mm².

For characteristic concrete strengths greater than 25 N/mm², the values in this table may be multiplied by $(f_{cu}/25)^{1/3}$. The value of f_{cu} should not be taken as greater than 40.

cl.16.5.4.5					
.2.3(b)					
21.2					
9.4.2					
Minimum shear strength, v_r = MAX (0.4, $0.4(f_{cu}/40)^{2/3}$), $f_{cu} \le 40$N/mm^2			**0.40**	N/mm^2	*cl.3.4.5.3*
), cl.16.5.5.1(c)					
Check v_d < 0.5.2d/a_v.v_c (corbel) | 1.0.2d/a_v.v_c (nib) for no links			**INVALID**	**0.91**	*cl.3.5.5.3,*
Concrete shear capacity $2d/a_v.v_c.(bd)$			**1758**	kN	*4.5.4, cl.3.4*
Check v_d >= 0.5.2d/a_v.v_c for design links		**0.91**	**VALID**	**5.00**	*cl.3.4.5.3*
$A_{sv} > a_v b(v_d - 2d/a_v.v_c)/(0.95f_{yv})$, $f_{yv} \le 460$N/mm^2 i.e. A_{sv} >			**1073**	mm^2	*cl.3.4.5.8,*
(Ensure $v_d - 2d/a_v.v_c \ge v_r$; Ensure $A_{sv} \ge 0.5A_s$ (HL);)					*cl.5.2.7.2.3*
$V_{cap} = (A_{sv,prov})/a_v.(0.95f_{yv}).d + 2d/a_v.v_c.(bd)$, $f_{yv} \le 460$N/mm^2			**4527**	kN	*cl.3.4.5.8,*
Area provided by all shear links within $0.75a_v$ (VL) or (2/3).d (HL), $A_{sv,prov}$			1508	mm^2	*5.9, cl.5.2*
(Note for vertical shear links, only those within central $0.75a_v$ deemed effective as per cl.3.4.5.9 BS8110)					
(Note for horizontal shear links, only those within upper (2/3).d deemed effective as per cl.5.2.7.2.3 BS8110)					
Design shear resistance utilisation			**71%**		**OK**
Applicability of vertical shear links		**Not Applicable**			
Applicability of horizontal shear links		**Horizontal Links**			
Pitch of shear links, s_{link} = {a_v (VL) or d (HL)} / (n_{sec}-1)			210	mm	
% Min shear reinforcement = 0.2%.b.s_{link}			483	mm^2	
% Min shear reinforcement utilisation			**32%**		**OK**
% Min combined tension and shear reinforcement = 0.0013bh			1346	mm^2	*cl.3.12.5.3*
% Min combined tension and shear reinforcement utilisation			**25%**		**OK**
% Max combined tension and shear reinforcement = 0.04bh			41400	mm^2	*cl.3.12.6.1*
% Max combined tension and shear reinforcement utilisation			**15%**		**OK**

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		jXXX	7		
		Member/Location			
Job Title	Member Design - Reinforced Concrete Corbel BS8110, E	Drg. Ref.			
Member Design - RC Corbel		Made by XX	Date 5/11/2026		Chd.

					EC2
Shear Reinforcement Design (EC2)					
Ultimate shear stress, $v_{ult} = V_d/bd$ (< $v_{Rd,max(\theta=45°)}$=0.18(1-f_{ck}/250).f_{ck}, f_{ck}≤50N		**2.00**	N/mm²		*3(3), cl.3.*
Ultimate shear strength, $v_{Rd,max(\theta=45°)}$=0.18(1-f_{ck}/250).f_{ck}, f_{ck}≤50N/mm²		**7.20**	N/mm²		*3(3), cl.3.*
Ultimate shear stress utilisation		**28%**			**OK**
Design shear stress, $v_d = V_d/bd$		**2.00**	N/mm²		
Enhanced shear strength, 2d/a_v.$v_{Rd,c}$ (< $v_{Rd,max(\theta=45°)}$=0.18(1-f_{ck}/25	*x 4.00*	**1.95**	N/mm²		*cl.6.2.3(8),*
Distance, a_v		200	mm		
(Shear capacity enhancement by calculating v_d at support and comparing against enhanced $v_{Rd,c}$ within					
2d of the support as cl.6.2.2(6) | cl.6.2.3(8) EC2 ***employed****, that of cl.6.2.1(8) EC2* ***not applicable****;)*					
Area of tensile steel reinforcement provided, $A_{s,prov,t}$		3927	mm²		
ρ_w = 100$A_{s,prov,t}$/bd		0.41	%		
$v_{Rd,c}$ = $C_{Rd,c}$.k(100$\rho_w f_{ck}$)$^{1/3}$+k_1.σ_{cp} ≥ v_{min}+k_1.σ_{cp}; v_{min}=0.035$k^{3/2}f_{ck}^{0.5}$, k_1=		**0.49**	N/mm²		*2(1), cl.3.*
$C_{Rd,c}$ = 0.18/γ_c = 0.18/1.5 = 0.12		0.12			*cl.6.2.2(1)*
k = 1 + √(200/d) ≤ 2.0		1.49			*cl.6.2.2(1)*
ρ_w = 100$A_{s,prov,t}$/bd ≤ 2		0.41	%		*cl.6.2.2(1)*
σ_{cp} = (F=0)/b(h=a_1+a_2) ≤ 0.2f_{cd}=0.2α_{cc}.f_{ck}/γ_c=0.2(1.0.f		0.00	N/mm²		*2(1), cl.3.*

Table 8.2 Shear resistance of slabs without shear reinforcement $v_{Rd,c}$ N/mm² (Class C30/37 concrete)

$\rho_l = A_s/bd$	Effective depth, d (mm)							
	≤ 200	225	250	300	350	400	500	600	750
0.25%	0.54	0.52	0.50	0.47	0.45	0.43	0.40	0.38	0.36
0.50%	0.59	0.57	0.56	0.54	0.52	0.51	0.48	0.47	0.45
0.75%	0.68	0.66	0.64	0.62	0.59	0.58	0.55	0.53	0.51
1.00%	0.75	0.72	0.71	0.68	0.65	0.64	0.61	0.59	0.57
1.25%	0.80	0.78	0.76	0.73	0.71	0.69	0.66	0.63	0.61
1.50%	0.85	0.83	0.81	0.78	0.75	0.73	0.70	0.67	0.65
2.00%	0.94	0.91	0.89	0.85	0.82	0.80	0.77	0.74	0.71
k	2.000	1.943	1.894	1.816	1.756	1.707	1.632	1.577	1.516

Table 8.3 Concrete strength modification factor

f_{ck} (N/mm²)	25	30	35	40	45	50
Modification factor	0.94	1.00	1.05	1.10	1.14	1.19

Minimum shear strength, v_r = 0.08/γ_s.$f_{ck}^{0.5}$, γ_s=1.15, f_{ck}≤50N/mm²		**0.49**	N/mm²		*2(5), cl.3.*
Check v_d < 2d/a_v.$v_{Rd,c}$ for no links		**INVALID**	**1.95**		*1(3) | cl.6.*
.5.8 Concrete shear capacity 2d/a_v.$v_{Rd,c}$.(bd)		**1883**	kN		*2(1), cl.6.2*
Check v_d >= 2d/a_v.$v_{Rd,c}$ for design links	**1.95**	**VALID**	**7.20**		*cl.6.2.1(5)*
cl.3.4.5.1 A_{sv} > bd.v_d/(0.87f_{yv})/(2d/a_v) (VL), f_{yv}≤600N/mm² i.e. A_{sv} >		**1343**	mm²		*cl.6.2.3(8),*
(Ensure A_{sv} > a_vb.v_r/(0.87f_{yv}); Ensure A_{sv} > 0.5V_d/(0.87f_{yv}) (VL) or A_{sv} ≥ 0.4b/0.87f_{yv} (HL))		*A1.3.2(3), cl.B.3.2,*			
cl.3.4.5.1 V_{cap} = 2d/a_v.($A_{sv,prov}$).(0.87f_{yv}) (VL) ≤ $V_{Rd,max,\theta}$, f_{yv}≤600N/mm²		**4834**	kN		*cl.6.2.3(8),*
Comp. strut angle, θ = 22° ≤ 0.5sin^{-1}{v_d/$v_{Rd,max(\theta=45°)}$} ≤ 45°		22.0	°		*cl.6.2.3(2)*
Area provided by all shear links within 0.75a_v (VL) or d (HL), $A_{sv,prov}$		2262	mm²		*cl.6.2.3(8)*
(Note for vertical shear links, only those within central 0.75a_v deemed effective as per cl.6.2.3(8) EC2)					
Design shear resistance utilisation		**59%**			**OK**
Applicability of vertical shear links	**Not Applicable**				
Applicability of horizontal shear links	**Horizontal Links**				
Pitch of shear links, s_{link} = {a_v (VL) or d (HL)} / (n_{sec}-1)		210	mm		
% Min shear reinforcement = 0.2%.b.s_{link}		483	mm²		
% Min shear reinforcement utilisation		**21%**			**OK**
% Min combined tension and shear reinforcement = MAX(0.0013, 0.26(f_{ctm}/f_y		2046	mm²		*l.9.2.1.1(1*
% Min combined tension and shear reinforcement utilisation		**33%**			**OK**
% Max combined tension and shear reinforcement = 0.04bh		41400	mm²		*l.9.2.1.1(3*
% Max combined tension and shear reinforcement utilisation		**15%**			**OK**

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										ACI318
Shear Reinforcement Design (ACI318)										
Ultimate shear stress, $v_{ult} = V_d/bd$ (< $\phi(0.66+0.17\lambda)\sqrt{f_c'}$, $f_c' \le 70N/mm^2$)								**1.98**	N/mm^2	*cl.22.5.5.1,*
Ultimate shear strength, $\phi(0.66+0.17\lambda)\sqrt{f_c'}$, $f_c' \le 70N/mm^2$								**4.40**	N/mm^2	*cl.22.5.5.1,*
Ultimate shear stress utilisation								**45%**		**OK**
Design shear stress, $v_d = V_d/bd$								**1.98**	N/mm^2	
Shear strength, v_c								**0.90**	N/mm^2	*5.5.1, cl.22*
	Distance, a_v							200	mm	
(Shear capacity enhancement by calculating v_d at support and comparing against enhanced v_c within										
d of the support ***not applicable****, that of cl.9.4.3.2 ACI318* ***not applicable****;)*										
	Area of tensile steel reinforcement provided, $A_{s,prov,t}$							3927	mm^2	
	$\rho_w = 100A_{s,prov,t}/bd$							0.41	%	
.2(2)	$v_c = \phi V_c/bd$	*Note $f_c' \le 70N/mm^2$*			Detailed			**0.90**	N/mm^2	
	$V_c = 0.17\lambda\sqrt{f_c'}b_w d$				*[Simplified] ϕV_c =*			871	kN	*5.5.1, cl.22*
.2(2)	where λ = {1.00 NWC, 0.75 LWC}					Normal weight				
					tailed MIN(a-c)] ϕV_c =			870	kN	*5.5.1, cl.22*
					Note $f_c' \le 70N/mm^2$					
					[Detailed (a)] ϕV_c =			870	kN	*5.5.1, cl.22*
					Note $f_c' \le 70N/mm^2$					
					[Detailed (b)] ϕV_c =			870	kN	*5.5.1, cl.22*
					Note $f_c' \le 70N/mm^2$					
					[Detailed (c)] ϕV_c =			1487	kN	*5.5.1, cl.22*
					Note $f_c' \le 70N/mm^2$					
	where λ = {1.00 NWC, 0.75 LWC}					Normal weight				
	Strength reduction factor for shear, ϕ = 0.75							0.75		*cl.21.2*
Minimum shear strength, v_r = MAX (0.35, 0.062$\sqrt{f_c'}$), $f_c' \le 70N/mm^2$								**0.44**	N/mm^2	*.3.3, cl.22.*
Check v_d < 0.5.v_c (corbel) | 1.0.v_c (nib) for no links								**INVALID**	**0.45**	*.3.1 | cl.7.*
.2(6)	Concrete shear capacity v_c.(bd)							**870**	kN	*cl.22.5.5.1*
Check v_d >= 0.5.v_c for design links							**0.45**	**VALID**	**4.40**	*cl.9.6.3.1*
cl.3.2.2(3)	$A_{sv} > a_v b(v_d - v_c)/(\phi f_{yv})$ (VL), $f_{yv} \le 420N/mm^2$ i.e. A_{sv} >							**1447**	mm^2	*.22.5.10.5.*
cl.B.3.3 PD	*(Ensure $A_{sv} > a_v b.v_r/f_{yv}$; Ensure $A_{sv} \ge 0.5(A_s - A_n)$ (HL);)*									*cl.16.5.5.2*
cl.3.2.2(3)	$V_{cap} = \phi.(A_{sv,prov})/a_v.f_{yv}.d + v_c.(bd)$ (VL) $\le \phi(0.66+0.17\lambda)\sqrt{f_c'}.(bd)$ (H							**4255**	kN	*10.5.3, cl.*
Area provided by all shear links within 1.00a_v (VL) or (2/3).d (HL), $A_{sv,prov}$								1508	mm^2	*cl.16.5.6.6*
(Note for horizontal shear links, only those within upper (2/3).d deemed effective as per cl.16.5.6.6 ACI318)										
Design shear resistance utilisation								**96%**		**OK**
Applicability of vertical shear links							**Not Applicable**			
Applicability of horizontal shear links							**Horizontal Links**			
Pitch of shear links, s_{link} = {a_v (VL) or d (HL)} / (n_{sec}-1)								210	mm	
% Min shear reinforcement = 0.2%.b.s_{link}								483	mm^2	
% Min shear reinforcement utilisation								**32%**		**OK**
% Min combined tension and shear reinforcement = 0.04(f_c'/f_y).bd								3866	mm^2	*.16.5.5.1(c*
% Min combined tension and shear reinforcement utilisation								**71%**		**OK**
% Max combined tension and shear reinforcement = 0.04bh								41400	mm^2	*N/A*
% Max combined tension and shear reinforcement utilisation								**15%**		**OK**

Table 22.5.5.1—Detailed method for calculating V_c

V_c		
Least of (a), (b), and (c):	$\left(0.16\lambda\sqrt{f_c'}+17\rho_w\frac{V_u d}{M_u}\right)b_w d$ [1]	(a)
	$(0.16\lambda\sqrt{f_c'}+17\rho_w)b_w d$	(b)
	$0.29\lambda\sqrt{f_c'}b_w d$	(c)

[1] M_u occurs simultaneously with V_u at the section considered.

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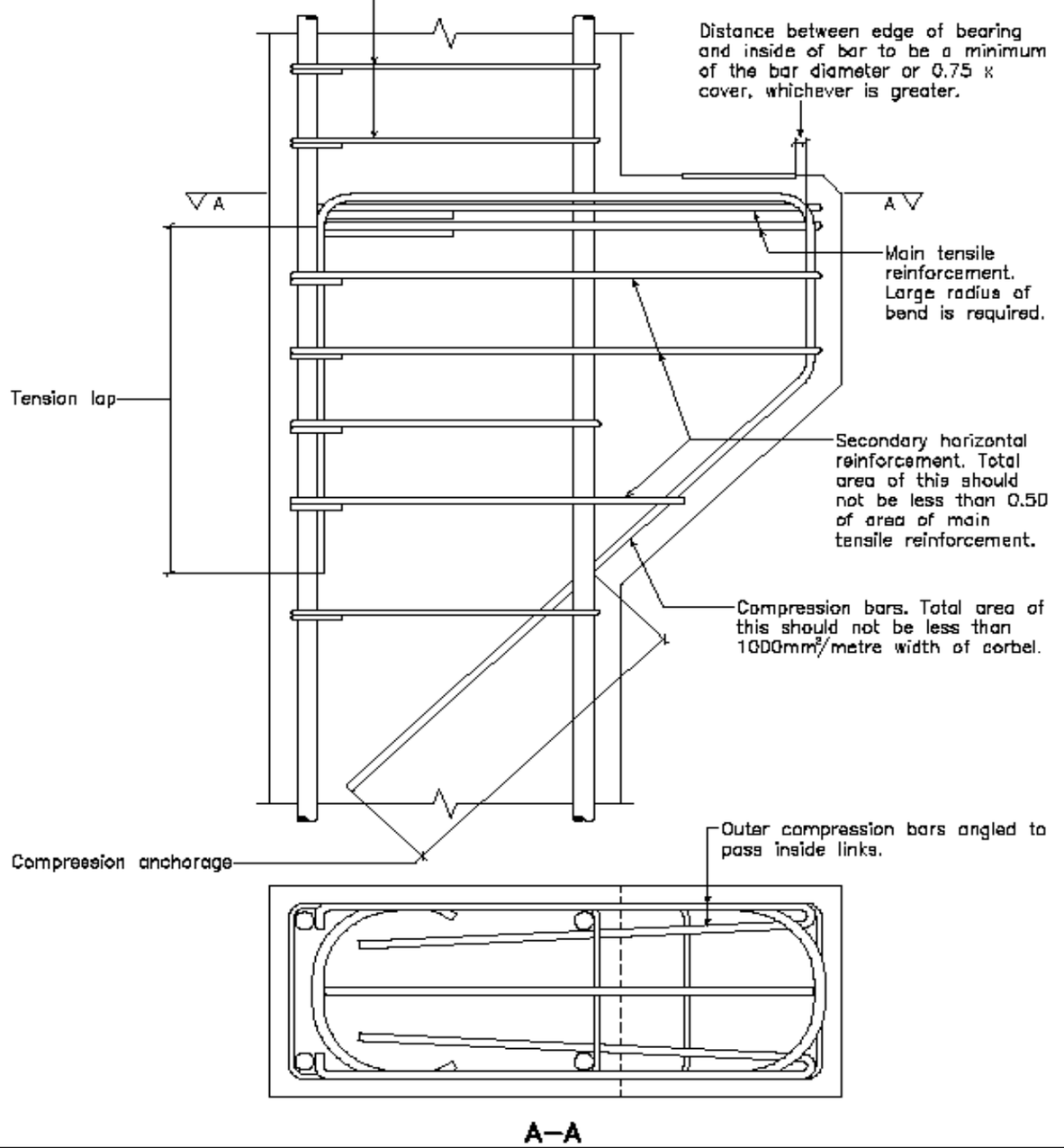
Standard Corbel Reinforcement Details

CORBELS MCB1

Without welds.

This detail is suitable when using 16mm dia. bars or smaller for the main tensile reinforcement.

Nominal cover:
Specified by designer.



A–A

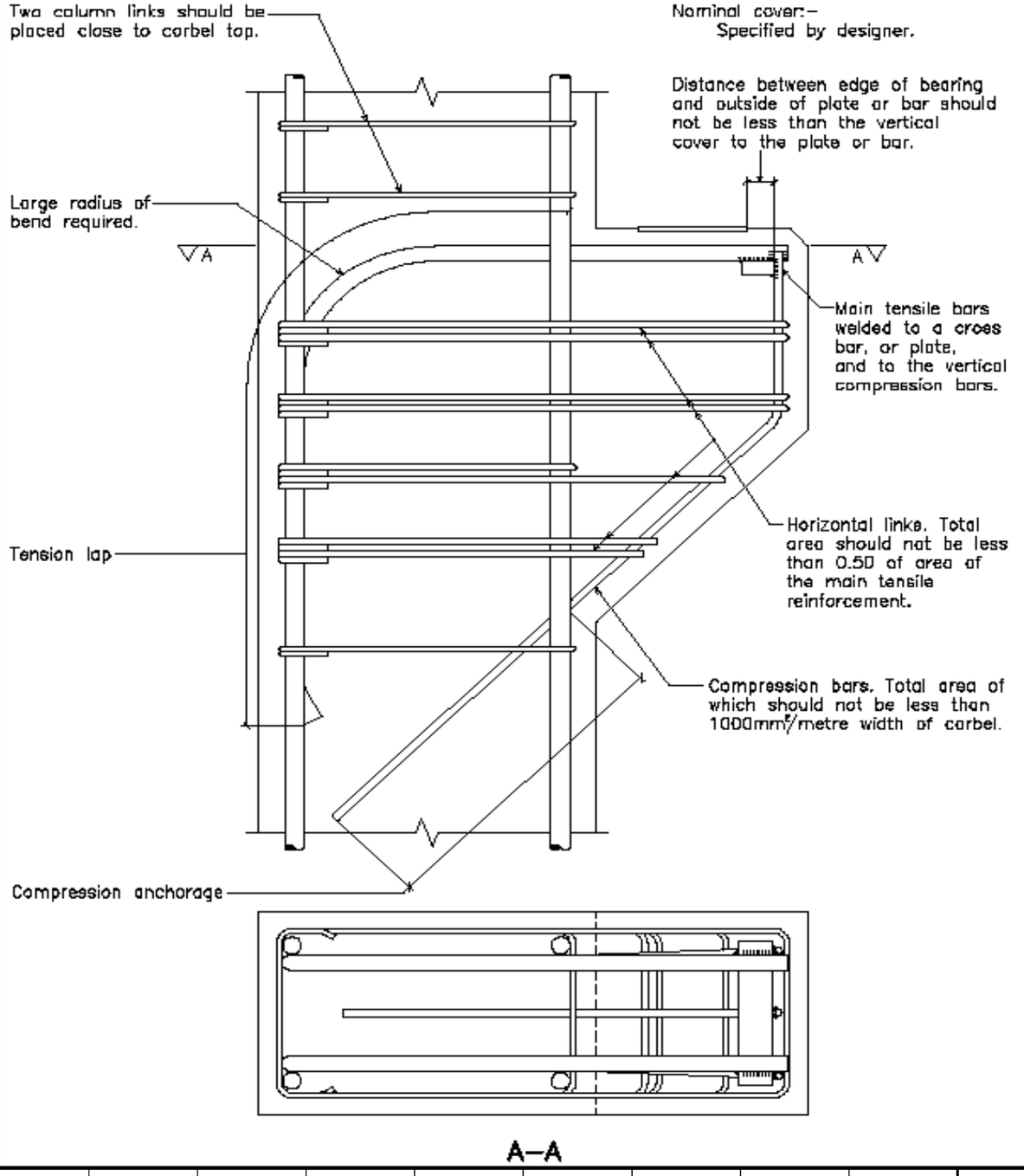
CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
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CORBELS MCB2

With welds.

This detail is suitable when using 20mm dia. bars or greater for the main tensile reinforcement.

Nominal cover:–
Specified by designer.



A–A

9.2.7 Arrangement of Reinforcement

The arrangement of reinforcement is very closely related to the design of corbels, half joints and nibs, and the designer must ensure that the detail design is clearly specified. He should refer to the OAP Design Guidance Notes, Concrete Construction: 4, May 1976. Other references are given in section 9.3.

In general small bar diameters, i.e. not larger than 16mm, should be used when detailing such elements. If larger diameter bars are used, it is likely that welding will be required. However, the designer should be aware that welding on site is not encouraged and if specified, often causes the contractor to suggest alternatives.

9.2.7.1 Corbels (BS 8110, Cl 5.2.7; EC2, Cl 5.4.4)

The use of small bar diameters, horizontal 'U' bars or links with easy bends is preferred, as shown in Model Detail MCB1. However, where the loading is high and the geometry restrictive, large bar diameters may be necessary, in which case welding them to a cross bar or plate may be the only solution. The size of this may be governed by the strength of weld. This is shown in Model Detail MCB2.

It is essential that the main tensile reinforcement is extended to as close to the outer face of the corbel as possible, and that it extends beyond the load bearing area by a minimum of the distance shown on the Model Details.

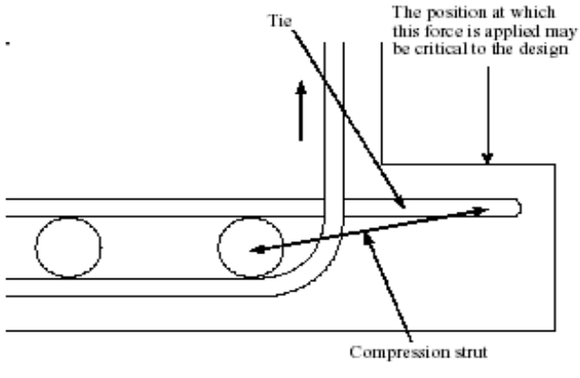
Where large horizontal forces are required to be transmitted into the corbel, a welded joint may be the only suitable solution. (See Park, R., and Paulay, T. Reinforced concrete structures.)

9.2.7.2 Half Joints in Beams

The use of inclined bars in half joints provides better control of cracking than other arrangements of reinforcement (See Clark L.A. and Thorogood P.: Serviceability behaviour of reinforced concrete half joints). However such bars are often difficult to fix correctly and can cause congestion of reinforcement. Great care is needed to ensure the use of practical details with inclined links or bent bars, especially when large bar diameters are required and a welded solution is adopted.

9.2.7.3 Continuous Nibs (BS 8110, Cl 5.2.8)

The arrangement of reinforcement for continuous nibs may control the depth of nib. Vertical 'U' bars or links should be used wherever possible, as shown in Model Detail MN1. However, where a shallow nib is required, e.g. for supporting brickwork, horizontal 'U' bars should be used, as shown in Model Detail MN2. The vertical leg of the links in the supporting beam must be designed to carry the loads from the nibs. The designer should note that it is necessary to reduce the value of d as the concrete in the nib below the vertical link does not contribute to the resistance. See Structures Note 1992NST 9, concerning Strut and Tie models.



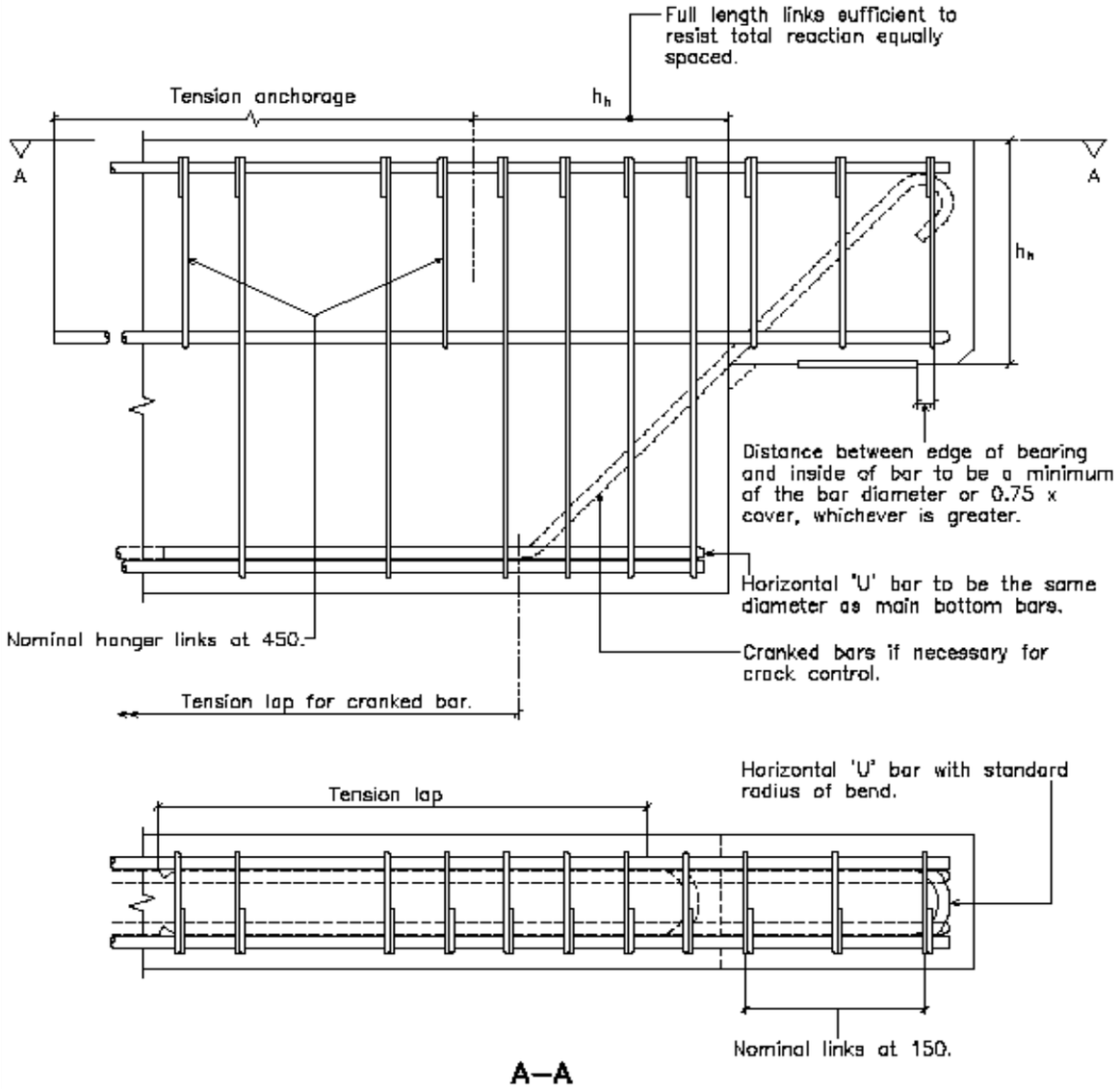
In situations where horizontal movement may occur between the nib and the supported member, the outer edge of the nib should be given a 20mm chamfer.

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		jXXX	12		
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HALF JOINTS MHJ

Note:—
Special design information must be given concerning the bearing pads.

Nominal cover:—
Specified by designer. (Normally 40 to main steel).



A—A

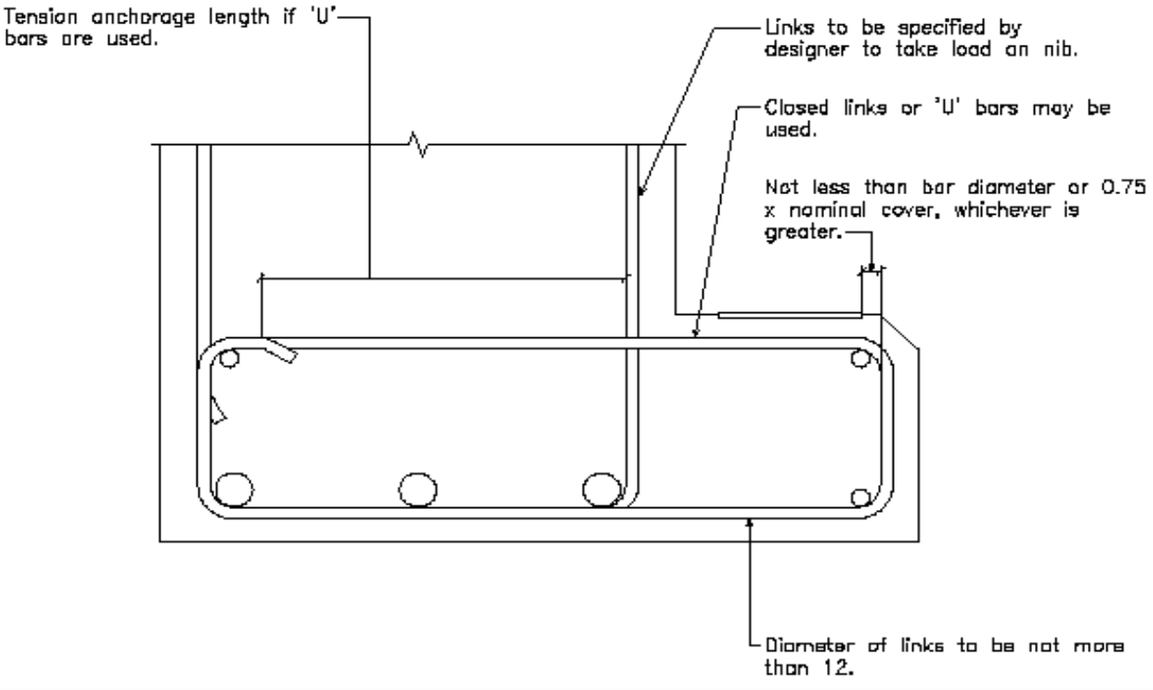
CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
		jXXX	13		
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NIBS MN1

This detail is suitable for half joints in slabs.

Minimum nominal overlap of reinforcement in nib and reinforcement in supported member to be 60.

Nominal cover:—
Specified by designer.

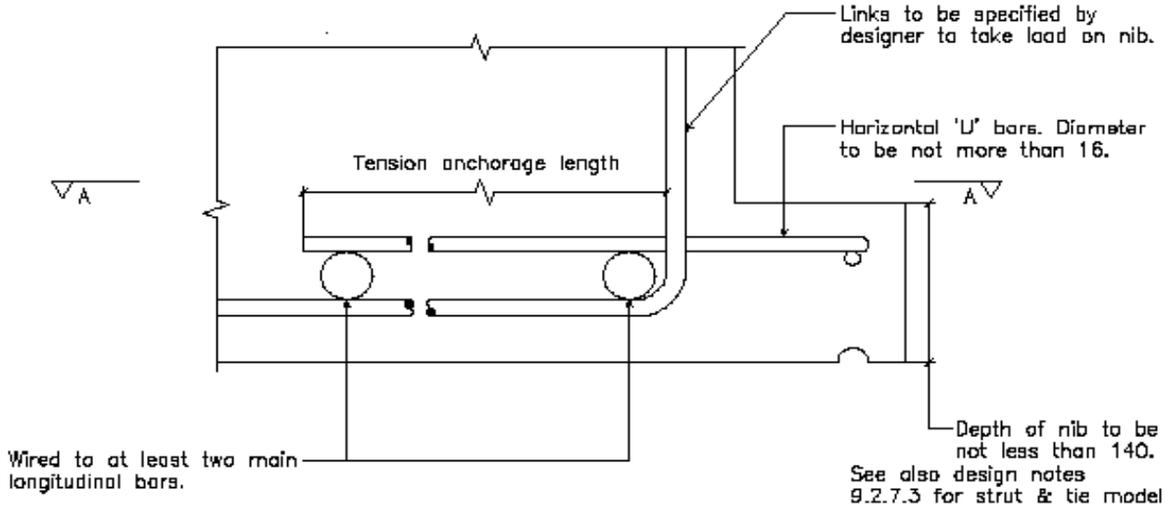


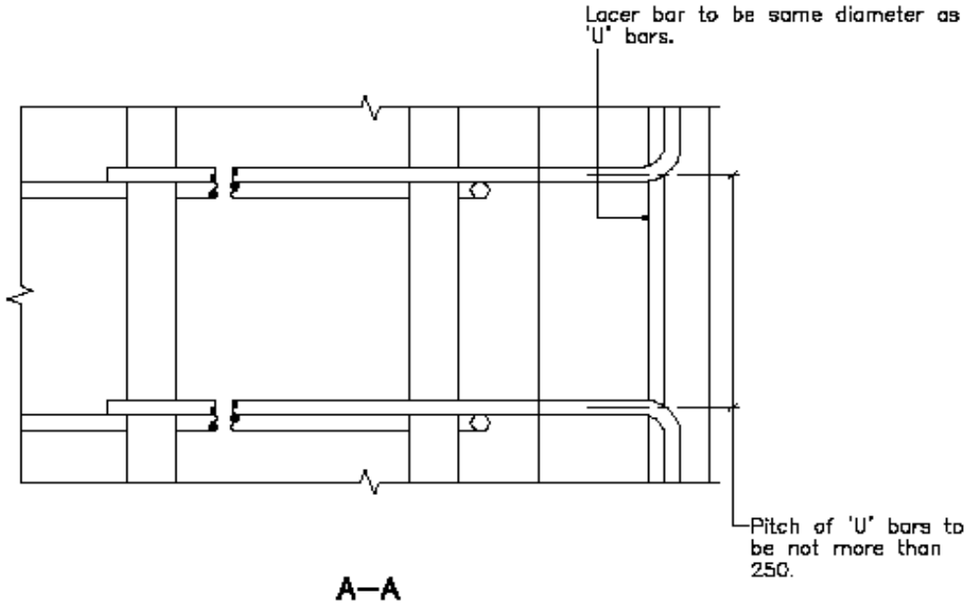
CONSULTING ENGINEERS	Engineering Calculation Sheet Consulting Engineers	Job No.	Sheet No.		Rev.
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		Member/Location			
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Member Design - RC Corbel		Made by **XX**	Date **5/11/2026**		Chd.

NIBS MN2

Shallow nibs not suitable for supporting brickwork.

Nominal cover:—
Specified by designer.





A—A