



Hybrid Injection System for Post-Installed Rebar Connections

B+BTec	
Munterij 8, NL 4762AH, Zevenbergen	
16	
1343	
1343-CPR-M 529-8	
ETA-16/0962	
EOTA TR 023	
Ø8 - 32 mm	
European Technical Assessment for Post-installed Rebar Connections	
DoP: 1343-CPR-M 529-8	

PRE-QUALIFIED TO
EOTA TR023

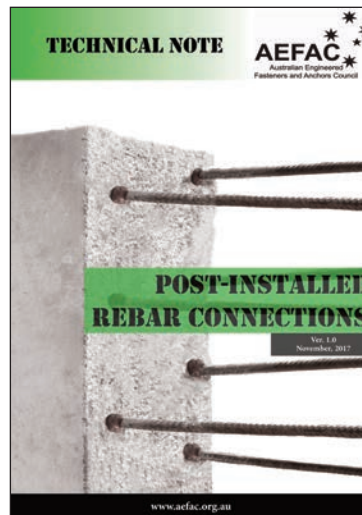


Use Conditions

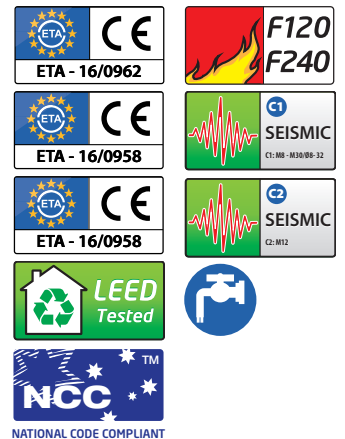
- Installation in reinforced and un-reinforced concrete C20/25 to C50/60, for Post Installed Rebar Ø8-32 mm
- For hammer/compressed air drilled holes
- Installation in dry and wet holes
- Not to be installed in flooded holes.
- Fire Rated
- Pre-qualified in accordance with AEFAC technical note for post-installed rebar

Typical Applications

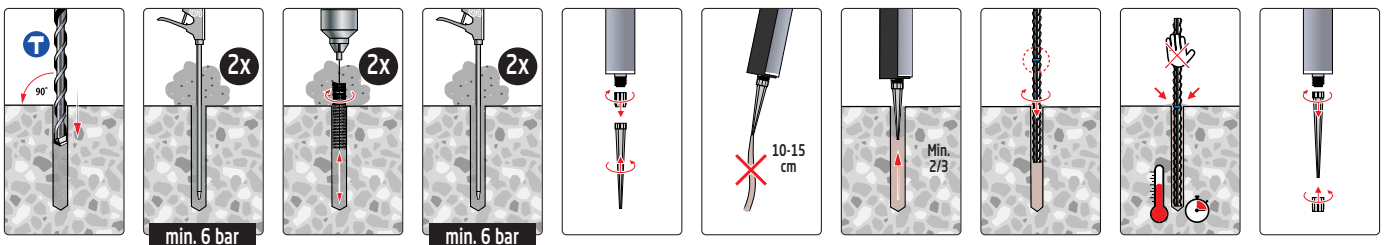
- Infrastructure construction (Roads, viaducts, harbours, high rise construction)



Additional Approvals & Test Reports



Installation Procedures



Curing Times¹

Concrete Temperature °C	-5 to -1	0 to +4	+5 to +9	+10 to +14	+15 to +19	+20 to +29	+30 to +40
Processing Time	50 min	25 min	15 min	10 min	6 min	3 min	2 min
Curing Time Dry Holes	5 h	3.5 h	2 h	1h	40 min	30 min	30 min
Curing Time Wet Holes	10 h	7 h	4 h	2h	80 min	60 min	60 min

¹ Cartridge Temperature must be between +5°C and +40°C.



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Material Properties

Properties	Test Method	Result
UV resistance		Pass
Watertightness	DIN EN 12390-8	Pass
Temperature stability		≤ 160°C
Density		1.78 kg / dm ³
Compressive strength	DIN EN 196-1	122 N / mm ²
Tensile strength	DIN EN ISO 527-2	14.9 N / mm ²
Flexural strength	DIN EN 196-1	22.2 N / mm ²
E modulus	DIN EN ISO 527-2	8300 N / mm ²
Shrinkage	DIN 52450	< 0.2 %
Hardness Shore A	DIN EN ISO 868	97.6
Electrical resistance	DIN IEC 93	7.2 x 10 ¹³ Ω m
Thermal conductivity	DIN EN 993-15	1.06 W/mK
Thermal heat capacity	DIN EN 993-15	1.090 J/kgK

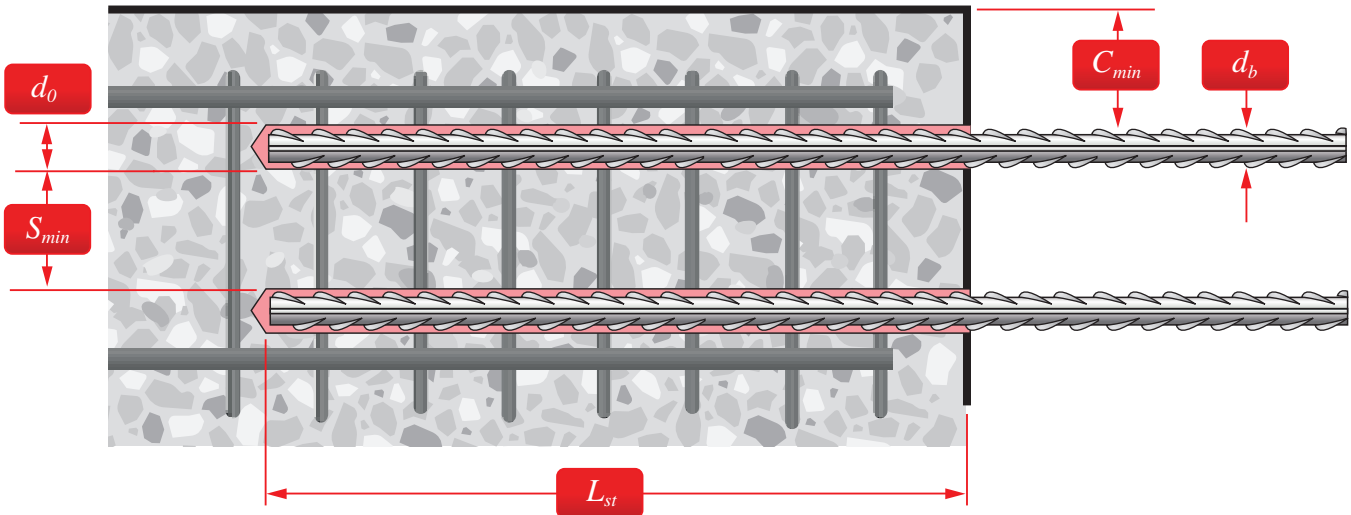
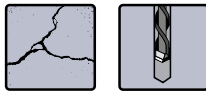
Chemical Resistance

Chemical Agent	Concentration	Resistant	Not Resistant
Acetic acid	10	•	
Acetone	100		•
Ammonia, aqueous solution	5	•	
Benzyl Alcohol	100		•
Chlorinated lime	10	•	
Citric acid	10	•	
Chlorine water, swimming pool	all	•	
Demineralized Water	100	•	
Diesel oil	100	•	
Ethanol	100		•
Ethyl Acetate	100		•
Formic acid	100		•
Fuel Oil	100	•	
Gasoline (premium grade)	100	•	
Glycol (Ethylene glycol)	100		•
Hydraulic fluid	100	•	
Hydrogen peroxide	10		•
Isopropyl alcohol	100		•
Lactic acid	10	•	
Linseed oil	100	•	
Lubricating oil	100	•	
Nitric acid	10		•
Methanol	100		•
Phosphoric acid	10	•	
Potassium Hydroxide ph 13.2	100	•	
Salt (Calcium Chloride)	100	•	
Sea water, salty	100	•	
Sodium carbonate	10	•	
Sulfuric acid	10	•	

Results shown in the table are applicable to brief periods of chemical contact with full cured adhesive (e.g. temporary contact with adhesive during a spill).



Design of post-installed rebar connections



Design Guidelines for Post-Installed Rebar Connections.

This document provides the design provisions and load tables for Post-installed Rebar Connections designed in accordance with AS3600:2009 Section 13.1.2 and AEFAC technical note – Post Installed Rebar Connections. To ensure post installed rebar performance is similar to that of cast-in rebar as outlined in AS3600:2009 only adhesive systems that are prequalified according to EOTA TR023 shall be used.

The embedment length of post-installed rebars should not be less than the development length obtained from equation (A) as highlighted below and in AS 3600 13.1.2.2.

The development length ($L_{sy,t}$) to develop the characteristic yield strength of a rebar (f_{sy}) in tension is given by equation (A).

EQUATION (A)

$$L_{sy,t} = \frac{(0.5k_1 k_3 f_{sy} d_b)}{k_2 \sqrt{f'_c}} \geq 29k_1 d_b$$

Where,

$$k_1 = \begin{cases} 1.3 & \text{for rebar with more than 300mm} \\ & \text{of concrete cover} \\ 1.0 & \text{otherwise} \end{cases}$$

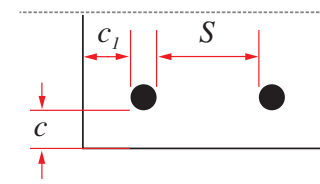
$$k_2 = (132 - d_b) / 100$$

$$k_3 = 1 - \frac{0.15(c_d - d_b)}{d_b}$$

(within the limits $0.7 \leq k_3 \leq 1.0$)

$$c_d = \text{Minimum of clear cover on each side and half of clear spacing between rebars}$$

$$f'_c \leq 65\text{MPa}$$



Straight bars
 $c_d = \min (S/2, c_1, c)$

Note: Equation A is valid for cracked and uncracked concrete if no additional requirement is provided in product ETA TR023.



Development Length to Develop less than Yield strength (L_{st})

Where it may be necessary to achieve a development length that develops a tensile stress (σ_{st}) less than yield due to design parameters or base material restrictions, the Development Length (L_{st}) for post-installed rebar shall be designed according to equation (B) below.

EQUATION (B)

$$L_{st} = L_{sy,t} \frac{\sigma_{st}}{f_{sy}}$$

The development length (L_{st}) calculated from equation (B) should be greater than $12d_b$ or other provisions as specified in AS 3600:2009. The reduced nominal capacity of the post-installed rebar (N_{st}) can be calculated from equation (C) or (D) below.

EQUATION (C)

$$N_{st} = A_s \sigma_{st}$$

EQUATION (D)

$$N_{st} = A_s f_{sy} \frac{L_{st}}{L_{sy,t}}$$

Where,

$$A_s = \frac{\pi d_b^2}{4}$$

Concrete Cover & Spacing of Rebar

Provisions for adequate concrete cover (C_{min}) are highlighted in EOTA TRO23 and in table A below. Where a drilling guide is used factors are reduced accordingly.

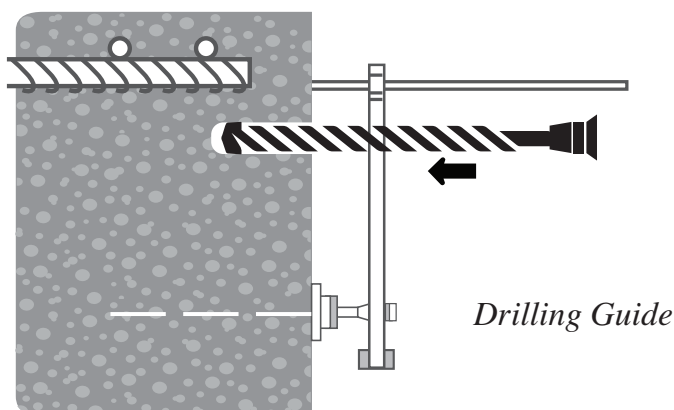
Minimum Concrete Cover (C_{min})

TABLE A

Drilling Method	d_b [mm]	Without Drilling Guide [mm]	With Drilling Guide [mm]
Hammer Drilling HD	<25	$30 + 0.06 \cdot L_{st} \geq 2d_b$	$30 + 0.02 \cdot L_{st} \geq 2d_b$
	≥ 25	$40 + 0.06 \cdot L_{st} \geq 2d_b$	$40 + 0.02 \cdot L_{st} \geq 2d_b$
Compressed Air Drilling CD	<25	$50 + 0.08 \cdot L_{st}$	$50 + 0.02 \cdot L_{st}$
	≥ 25	$60 + 0.08 \cdot L_{st}$	$60 + 0.02 \cdot L_{st}$

Minimum (clear) spacing between post-installed rebars (S_{min}) is:

$$S_{min} = 40mm \geq 4 d_b$$





Design Values of Ultimate Bond Resistance² f_{bd} in N/mm^2

Rebar	Concrete Class						
	C20	C25	C32	C35	C40	C45	C50
Ø8 - 32 mm	2.3	2.7	3.2	3.4	3.7	4.0	4.3

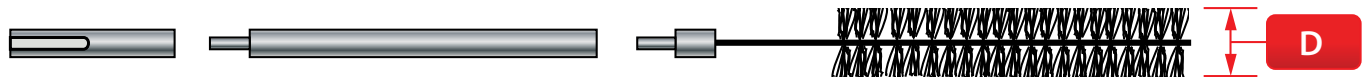
Important: Information contained in this documents shall be read in conjunction with the provisions and guidelines set out in;-

- AS 3600:2009 (Concrete Structures)
- AEFAC Technical Note (Post Installed Rebar Connections)
- EOTA TR023 (Assessment of Post Installed Rebar Connections)
- Product ETA TR023 Assessment

For splicing of reinforcement please follow guidelines highlighted in AS3600:2009 section 13.2.

Installation Dimensions

Rebar Size	d_b		Ø10	Ø12	Ø16	Ø20	Ø24	Ø28	Ø32
Hole Diameter	d_o	[mm]	14	16	20	25	32	35	40
Min. Anchoring Length	$12d_b$	[mm]	120	144	192	240	288	336	384
Max. Embedment Depth	L_{max}	[mm]	1000	1200	1600	2000	2000	2000	2000
Min. (clear) Spacing	S_{min}	[mm]	40	48	64	80	96	112	128
Required Volume per cm Embedment Depth	V_s	[ml/cm]	0.90	1.06	1.36	2.12	3.76	4.16	5.43



Steel Brush & Piston Plug Dimensions

Rebar Size	d_b		Ø10	Ø12	Ø16	Ø20	Ø24	Ø28	Ø32
Brush Diameter	D	[mm]	16	18	22	27	34	37	41,5
Min. Brush Diameter	D_{min}	[mm]	14.5	16.5	20.5	25.5	32.5	35.5	40.5
Piston Plug	#	-	14	16	20	25	32	35	40



Stress Development in Reinforcement

Development length for post-installed reinforcement in tension in accordance with AS3600-2009 (clause 13.1.2)

Rebar designation			N10	N12	N16	N20	N24	N28	N32
Diameter of rebar	d_b	(mm)	10	12	16	20	24	28	32
Drill hole size	d_o	(mm)	14	16	20	25	32	35	37
Cross Sectional Area of Rebar	A_s	(mm ²)	79	113	201	314	452	616	804
Yield Strength of Rebar (D500N)	f_{sy}	(kN)	39.5	56.5	100.5	157	226	308	402
$1.2 \times d_b$ (min.)		(mm)	120	144	192	240	288	336	384
$29k_1 d_b$		(mm)	290	348	464	580	696	812	928
$(0.5k_1 k_3 f_{sy} d_b) / k_2 \sqrt{f'_c}$	$f'_c = 20$	(mm)	389	475	655	849	1056	1279	1521
	$f'_c = 32$	(mm)	308	376	518	671	835	1011	1202

Assumptions in accordance with AS3600-2009 Section 13.1.2

k_1			1.0	1.0	1.0	1.0	1.0	1.0	1.0
k_2			1.22	1.20	1.16	1.12	1.08	1.04	1.00
k_3			0.85	0.85	0.85	0.85	0.85	0.85	0.85
c (Clear cover to concrete edge)*		(mm)	20	24	32	40	48	56	64
s (Clear spacing b/w bars)		(mm)	40	48	64	80	96	112	128
s min.			40	48	64	80	96	112	128

* c clear cover shall be the greater of the c value above and the value highlighted in table A (page 3) which is based on drilling process.

L_{st} Development Length less than yield -AS3600-2009 (for $C_d=2 \times d_b$) $k_3=0.85$, 20MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	12.2							
145	14.7	17.3						
200	20.3	23.8	30.7					
240	24.3	28.6	36.8	44.4				
300	30.4	35.7	46.0	55.5	64.3			
340	34.5	40.5	52.2	63.0	72.8	81.8		
389	39.5	46.3	59.7	72.0	83.3	93.6	102.9	
440		52.4	67.5	81.5	94.3	105.9	116.4	
475		56.5	72.9	87.9	101.8	114.3	125.6	
540			82.8	100.0	115.7	130.0	142.8	
620			95.1	114.8	132.8	149.2	164.0	
655			100.5	121.3	140.3	157.7	173.2	
700				129.6	150.0	168.5	185.1	
740				137.0	158.5	178.1	195.7	
800				148.1	171.4	192.6	211.6	
849				157.0	181.9	204.3	224.6	
990					212.1	238.3	261.9	
1056					226.0	254.2	279.3	
1100						264.8	290.9	
1279						308.0	338.3	
1400							370.3	
1521							402.0	
Length to develop yield L_{syt}	(mm)	389	475	655	849	1056	1279	1521

L_{st} Development Length less than yield -AS3600-2009 (for $C_d=2 \times d_b$) $k_3=0.85$, 32MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	15.4							
145	18.6	21.8						
200	25.7	30.1	38.8					
240	30.8	36.1	46.6	56.2				
308	39.5	46.4	59.8	72.1	83.5			
340		51.2	66.0	79.6	92.1	103.5		
376		56.5	73.0	88.1	101.9	114.5		
440			85.4	103.0	119.2	134.0	147.2	
475			92.2	111.2	128.7	144.6	158.9	
518			100.5	121.3	140.4	157.7	173.3	
620				145.2	168.0	188.8	207.4	
671				157.0	181.8	204.3	224.5	
700					189.7	213.1	234.2	
740					200.5	225.3	247.6	
800					216.8	243.6	267.7	
835					226.0	254.2	279.4	
990						301.4	331.2	
1011						308.0	338.2	
1100							368.0	
1150							384.8	
1202							402.0	
Length to develop yield L_{syt}	(mm)	308	376	518	671	835	1011	1202



Stress Development in Reinforcement

Development length for post-installed reinforcement in tension in accordance with AS3600-2009 (clause 13.1.2)

Rebar designation			N10	N12	N16	N20	N24	N28	N32
Diameter of rebar	d_b	(mm)	10	12	16	20	24	28	32
Drill hole size	d_o	(mm)	14	16	20	25	32	35	37
Cross Sectional Area of Rebar	A_s	(mm ²)	79	113	201	314	452	616	804
Yield Strength of Rebar (D500N)	f_{sy}	(kN)	39.5	56.5	100.5	157	226	308	402
$12 \times d_b$ (min.)		(mm)	120	144	192	240	288	336	384
$29k_1 d_b$		(mm)	290	348	464	580	696	812	928
$(0.5k_1 k_2 f_{sy} d_b)$ $k_2 \sqrt{f_c}$	$f_c = 40$	(mm)	275	336	463	600	747	905	1075
	$f_c = 50$	(mm)	246	301	415	537	668	809	962

Assumptions in accordance with AS3600-2009 Section 13.1.2

k_1			1.0	1.0	1.0	1.0	1.0	1.0	1.0
k_2			1.22	1.20	1.16	1.12	1.08	1.04	1.00
k_3			0.85	0.85	0.85	0.85	0.85	0.85	0.85
c (Clear cover to concrete edge)*		(mm)	20	24	32	40	48	56	64
s (Clear spacing b/w bars)		(mm)	40	48	64	80	96	112	128
s min.			40	48	64	80	96	112	128

* c clear cover shall be the greater of the c value above and the value highlighted in table A (page 3) which is based on drilling process.

L_{st} Development Length less than yield - AS3600-2009 (for $C_d=2 \times d_b$) $k_3=0.85$, 40MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	163							
145	198	236						
200	272	325	433					
240	327	390	520	628				
290	39.5	471	628	759	879			
348		56.5	754	911	1054	1185		
390			845	1021	1182	1328	1459	
440			953	1152	1333	1498	1646	
464			100.5	121.5	140.6	157.9	173.6	
520				136.2	157.6	177.0	194.5	
600				157.0	181.8	204.2	224.4	
650					196.9	221.3	243.1	
700					212.1	238.3	261.8	
747					226.0	254.3	279.4	
800						272.3	299.2	
850						289.3	317.9	
905						308.0	338.5	
950							355.4	
1075							402.0	
Length to develop yield L_{syt}	(mm)	290	348	464	600	747	905	1075

L_{st} Development Length less than yield - AS3600-2009 (for $C_d=2 \times d_b$) $k_3=0.85$, 50MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	163							
145	198	236						
200	272	325	433					
240	327	390	520	650				
290	39.5	471	628	786	943			
348		56.5	754	943	1131	1320		
390			845	1056	1268	1479	1631	
440			953	1192	1430	166.9	184.0	
464			100.5	125.7	150.8	176.0	194.0	
520				140.8	169.0	197.2	217.5	
580				157.0	188.5	219.9	242.6	
650					211.3	246.5	271.8	
696					226.0	263.9	291.1	
747						283.3	312.4	
812						308.0	339.6	
850							355.5	
905							378.5	
962							402.0	
Length to develop yield L_{syt}	(mm)	290	348	464	580	696	812	962



Stress Development in Reinforcement

Development length for post-installed reinforcement in tension in accordance with AS3600-2009 (clause 13.1.2)

Rebar designation			N10	N12	N16	N20	N24	N28	N32
Diameter of rebar	d_b	(mm)	10	12	16	20	24	28	32
Drill hole size	d_o	(mm)	14	16	20	25	32	35	37
Cross Sectional Area of Rebar	A_s	(mm ²)	79	113	201	314	452	616	804
Yield Strength of Rebar (D500N)	f_{sy}	(kN)	39.5	56.5	100.5	157	226	308	402
$1.2 \times d_b$ (min.)		(mm)	120	144	192	240	288	336	384
$29k_1 d_b$		(mm)	290	348	464	580	696	812	928
$(0.5k_1 k_3 f_{sy} d_b)$ $k_2 \sqrt{f'_c}$	$f'_c = 20$	(mm)	321	391	540	699	870	1054	1252
	$f'_c = 32$	(mm)	254	309	427	552	687	833	990

Assumptions in accordance with AS3600-2009 Section 13.1.2

k_1			1.0	1.0	1.0	1.0	1.0	1.0	1.0
k_2			1.22	1.20	1.16	1.12	1.08	1.04	1.00
k_3			0.7	0.7	0.7	0.7	0.7	0.7	0.7
c (Clear cover to concrete edge)*		(mm)	30	36	48	60	72	84	96
s (Clear spacing b/w bars)		(mm)	60	72	96	120	144	168	192
s min.			40	48	64	80	96	112	128

* c clear cover shall be the greater of the c value above and the value highlighted in table A (page 3) which is based on drilling process.

L_{st} Development Length less than yield - AS3600-2009 (for $C_d \geq 3 \times d_b$) $k_3=0.7$, 20MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	14.7							
145	17.8	21.0						
200	24.5	28.9	37.3					
240	29.4	34.7	44.7	54.0				
321	39.5	46.4	59.8	72.2	83.5			
340		49.1	63.3	76.4	88.5	99.4		
391		56.5	72.8	87.9	101.7	114.3	125.6	
440			82.0	98.9	114.5	128.6	141.3	
500			93.1	112.4	130.1	146.1	160.6	
540			100.5	121.3	140.4	157.7	173.3	
620				139.4	161.3	181.2	199.1	
680				152.9	176.9	198.7	218.4	
699				157.0	181.7	204.2	224.3	
740					192.5	216.3	237.7	
800					208.1	233.8	256.9	
870					226.0	253.9	279.0	
990						289.3	318.0	
1054						308.0	338.4	
1100							353.3	
1150							369.4	
1252							402.0	
Length to develop yield $L_{sy,t}$	(mm)	321	391	540	699	870	1054	1252

L_{st} Development Length less than yield - AS3600-2009 (for $C_d \geq 3 \times d_b$) $k_3=0.7$, 32MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	16.3							
150	20.3	24.4						
200	27.1	32.5	43.3					
290	39.5	47.1	62.8	78.6				
300		48.8	65.0	81.3	97.5			
320		52.0	69.3	86.7	104.0			
348		56.5	75.4	94.3	113.1	128.7		
400			86.7	108.3	130.0	147.9	162.5	
464			100.5	125.7	150.8	171.5	188.5	
500				135.4	162.5	184.8	203.1	
540				146.3	175.5	199.6	219.4	
580				157.0	188.5	214.4	235.6	
620					201.5	229.2	251.9	
696					226.0	257.3	282.8	
700						258.8	284.4	
740						273.6	300.6	
800						295.8	325.0	
833						308.0	338.4	
990							402.0	
Length to develop yield $L_{sy,t}$	(mm)	290	348	464	580	696	833	990



Stress Development in Reinforcement

Development length for post-installed reinforcement in tension in accordance with AS3600-2009 (clause 13.1.2)

Rebar designation			N10	N12	N16	N20	N24	N28	N32
Diameter of rebar	d_b	(mm)	10	12	16	20	24	28	32
Drill hole size	d_o	(mm)	14	16	20	25	32	35	37
Cross Sectional Area of Rebar	A_s	(mm ²)	79	113	201	314	452	616	804
Yield Strength of Rebar (D500N)	f_{sy}	(kN)	39.5	56.5	100.5	157	226	308	402
1.2 x d_b (min.)		(mm)	120	144	192	240	288	336	384
2.9k ₁ d_b		(mm)	290	348	464	580	696	812	928
	$f'_c = 40$	(mm)	227	277	382	494	615	745	885
	$f'_c = 50$	(mm)	203	247	341	442	550	666	792

Assumptions in accordance with AS3600-2009 Section 13.1.2

			N10	N12	N16	N20	N24	N28	N32
k_1			1.0	1.0	1.0	1.0	1.0	1.0	1.0
k_2			1.22	1.20	1.16	1.12	1.08	1.04	1.00
k_3			0.7	0.7	0.7	0.7	0.7	0.7	0.7
c(Clear cover to concrete edge)*		(mm)	30	36	48	60	72	84	96
s(Clear spacing b/w bars)		(mm)	60	72	96	120	144	168	192
s min.			40	48	64	80	96	112	128

* c clear cover shall be the greater of the c value above and the value highlighted in table A (page 3) which is based on drilling process.

L_{st} Development Length less than yield - AS3600-2009 (for $C_d \geq 3 \times d_b$) $k_3=0.7$, 40MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	16.3							
150	20.3	24.4						
200	27.1	32.5	43.3					
290	39.5	47.1	62.8	78.6				
300		48.8	65.0	81.3	97.5	113.8		
320		52.0	69.3	86.7	104.0	121.3	138.7	
348		56.5	75.4	94.3	113.1	132.0	150.8	
400			86.7	108.3	130.0	151.7	173.4	
464			100.5	125.7	150.8	176.0	201.1	
500				135.4	162.5	189.6	216.7	
540				146.3	175.5	204.8	234.0	
580				157.0	188.5	219.9	251.4	
620					201.5	235.1	268.7	
696					226.0	263.9	301.6	
700						265.4	303.4	
740						280.6	320.7	
812						308.0	351.9	
833							361.0	
928							402.0	
Length to develop yield L_{syt}	(mm)	290	348	464	580	696	812	928

L_{st} Development Length less than yield - AS3600-2009 (for $C_d \geq 3 \times d_b$) $k_3=0.7$, 50MPa

L_{st} (mm)	Reinforcing Bar Capacity (kN)							
	N10	N12	N16	N20	N24	N28	N32	
120	16.3							
150	20.3	24.4						
200	27.1	32.5	43.3					
290	39.5	47.1	62.8	78.6				
300		48.8	65.0	81.3	97.5	113.8		
320		52.0	69.3	86.7	104.0	121.3	138.7	
348		56.5	75.4	94.3	113.1	132.0	150.8	
400			86.7	108.3	130.0	151.7	173.4	
464			100.5	125.7	150.8	176.0	201.1	
500				135.4	162.5	189.6	216.7	
540				146.3	175.5	204.8	234.0	
580				157.0	188.5	219.9	251.4	
620					201.5	235.1	268.7	
696					226.0	263.9	301.6	
700						265.4	303.4	
740						280.6	320.7	
812						308.0	351.9	
833							361.0	
928							402.0	
Length to develop yield L_{syt}	(mm)	290	348	464	580	696	812	928



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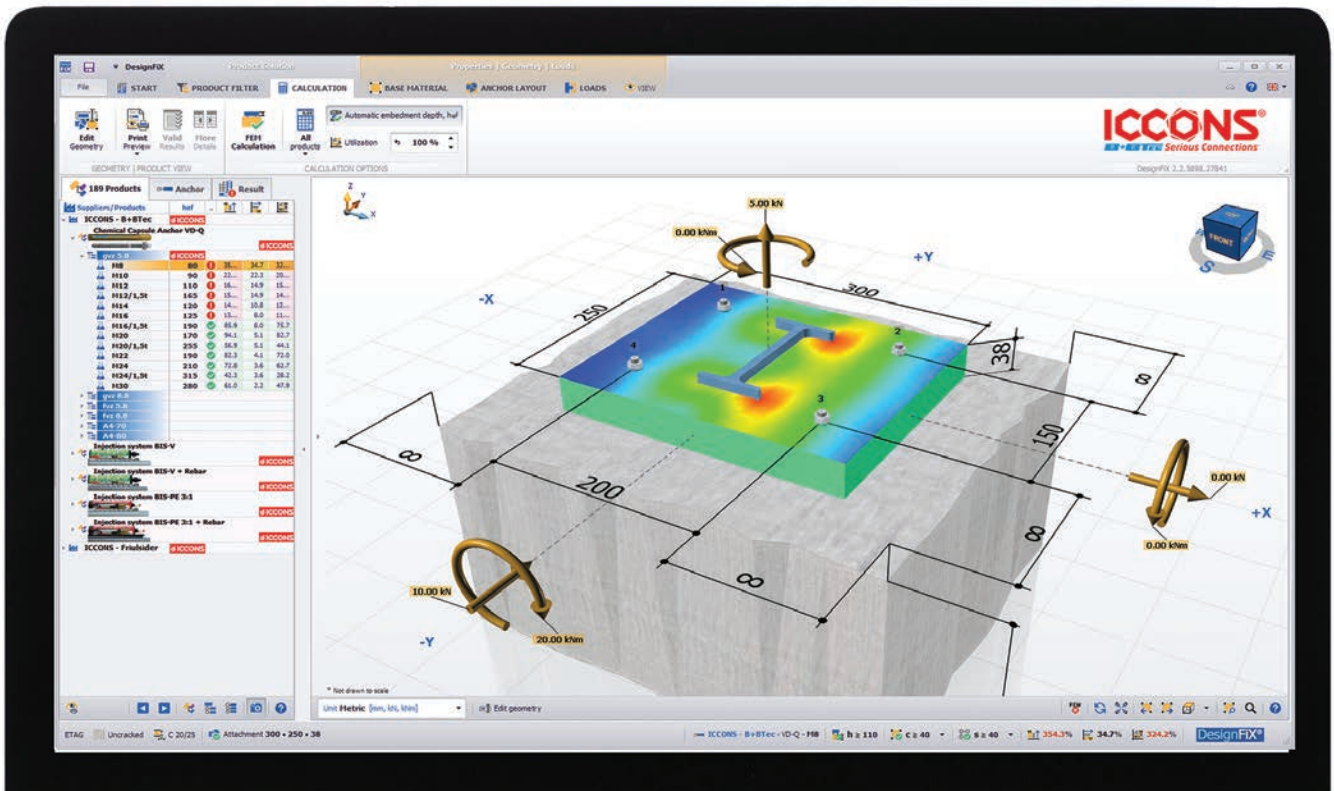
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