RF ROUND FERRULE LIFTING SOCKET

PRODUCT FEATURES

- Economical solution for cast-in placement anchor.
- Ideal for shallow embedment depth.
- Very high load when tied to reinforcing to ensure integral part of structure.
- Highly suitable for lifting of concrete panels.
- Excellent product replacement to cast-in channel for curtain wall fixings.
- Anchoring point at post tensioning or pre-stressing slab.

LOADING ZONES

MATERIAL SPECIFICATIONS

- Carbon steel zinc galvanised to min. 5µm.
- Carbon steel hot dipped galvanised to min. 40µm.
- Stainless steel 304 (A2) and 316 (A4).

SUBSTRATES

- RC concrete C20/25 to C50/60 at maximum according to EN 206-1:2000-12.

BASIC LOADING DATA FOR RF; RF-GH; RF-S & RF-SS

- For static and quasi-static loadings.
- For non-cracked concrete only.
- Only a single anchor is considered.
- No anchor spacing and edge distance influences.
- Concrete compressive strength C20/25 ($f_{ck,cube}$ = 25 N/mm²).

CHARACTERISTIC RESISTANCE [F_{Rk}]

Anchor Size		M10 x 45	M12 x 55	M12 x 70	M16 x 70	M16 x 95	M20 x 70	M20 x 95	M24 x 95	M24 x 120
Tensile Load, N_{Rk}	[kN]	13.5	18.2	26.1	32.3	51.0	35.1	55.5	69.5	92.0
Shear Load, V_{Rk}	[kN]									
~ Carbon Steel		17.4	25.3	25.3	47.1	47.1	73.5	73.5	105.9	105.9
~ Stainless Steel		24.4	35.4	35.4	65.9	65.9	102.9	102.9	148.3	148.3

DESIGN RESISTANCE [F_{Rd}]

Anchor Size		M10 x 45	M12 x 55	M12 x 70	M16 x 70	M16 x 95	M20 x 70	M20 x 95	M24 x 95	M24 x 120
Tensile Load, N_{Rd}	[kN]	9.0	12.1	17.4	21.5	34.0	23.4	37.0	46.3	61.3
Shear Load, V_{Rd}	[kN]									
~ Carbon Steel		13.9	20.2	20.2	37.7	37.7	58.8	58.8	84.7	84.7
~ Stainless Steel		15.6	22.7	22.7	42.3	42.3	66.0	66.0	95.0	95.0

RECOMMENDED LOAD [F_{Rec}]

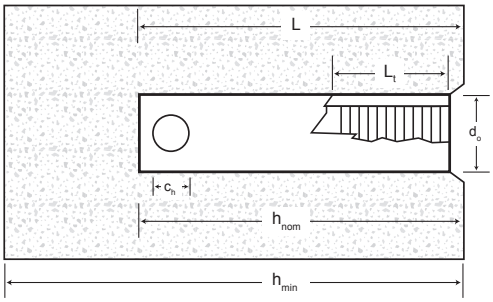
Anchor Size		M10 x 45	M12 x 55	M12 x 70	M16 x 70	M16 x 95	M20 x 70	M20 x 95	M24 x 95	M24 x 120
Tensile Load, N_{Rec}	[kN]	6.4	8.6	12.4	15.4	24.3	16.7	26.4	33.1	43.8
Shear Load, V_{Rec}	[kN]									
~ Carbon Steel		9.9	14.5	14.5	26.9	26.9	42.0	42.0	60.5	60.5
~ Stainless Steel		11.2	16.2	16.2	30.2	30.2	47.1	47.1	67.9	67.9

RF ROUND FERRULE LIFTING SOCKET

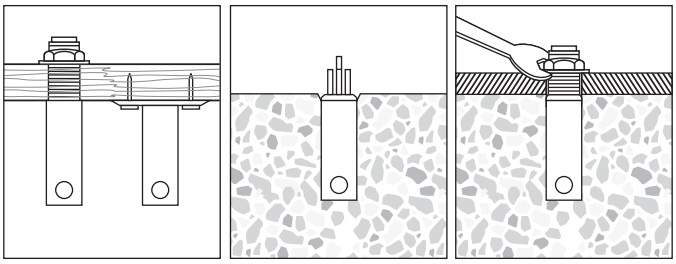
SETTING DETAILS

ANCHOR SIZE		M10 x 45	M12 x 55	M12 x 70	M16 x 70	M16 x 95	M20 x 70	M20 x 95	M24 x 95	M24 x 120
Anchor Length, L	[mm]	45	55	70	70	95	70	95	95	120
Thread Length, L_t	[mm]	20	25	35	35	40	35	40	50	75
Recommended Torque, T_{inst}	[Nm]	17	30		75		144		250	
Embedment Depth, h_{nom}	[mm]	50	60	75	75	100	75	100	100	125
Effective Anchorage Depth, h_{ef}	[mm]	33	40	55	50	75	50	75	70	95
Outer Diameter, d_0	[mm]	16	17		22		28		32	
Cross Hole Diameter, d_c	[mm]	9			13				15	
Bar Size At Cross Hole	[mm]	R8			R10				R12	
Minimum Concrete Thickness, h_{min}	[mm]	70	85	105	105	145	105	145	145	180
Critical Anchor Spacing, s_{cr}	[mm]	99	120	165	150	225	150	225	210	285
Minimum Anchor Spacing, s_{min}	[mm]	33	40	55	50	75	50	75	70	95
Critical Edge Distance, c_{cr}	[mm]	50	60	83	75	113	75	113	105	143
Minimum Edge Distance, c_{min}	[mm]	33	40	55	50	75	50	75	70	95

SETTING DIAGRAM



INSTALLATION PROCEDURES



1. Secure firmly the ferrule on the formwork and reinforcing system, if required.
2. Pour the concrete.
3. Upon concrete cured, remove the formwork leaving the ferrule firmly embedded.
4. Attach fixture upon concrete cured.

MECHANICAL PROPERTIES

ANCHOR SIZE		M10	M12	M16	M20	M24
Cross Sectional Area, A_s	[mm^2]	58.0	84.3	157.0	245.0	353.0
Nominal Tensile Strength, f_{uk}	[N/mm^2]					
~ Carbon Steel		500	500	500	500	500
~ Stainless Steel		700	700	700	700	700
Elastic Moment Of Resistance, W_{el}	[mm^3]	62.3	109.2	277.5	540.9	935.5
Design Bending Moment, $M_{Rd,s}$	[Nm]					
~ Carbon Steel		29.9	52.4	133.2	259.6	449.0
~ Stainless Steel		33.5	58.8	149.4	291.3	503.7

The design bending moment is derived from $M_{Rd,s} = M_{Rk,s} / \gamma_{Ms,N}$ where the partial safety factor is 1.25 for carbon steel and 1.56 for stainless steel. The recommended bending moment is derived from $M_{Rec,s} = M_{Rd,s} / \gamma_F$ where the partial safety factor is 1.4.

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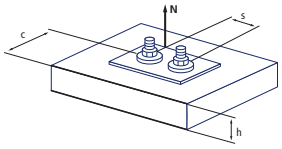
TENSION LOAD [N_{Rd}]

Design Tensile Resistance, N_{Rd}: lower value of [$N_{Rd,s}$; $N_{Rd,c}$]

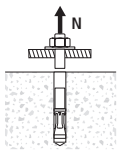
Design Steel Tensile Resistance: $N_{Rd,s}$

Design Concrete Cone / Pull-Out Resistance: $N_{Rd,c} = N^0_{Rd,c} * \Psi_{\beta,N} * \Psi_{s,N} * \Psi_{c,N}$



STEEL TENSILE RESISTANCE [$N_{Rd,s}$]

- For static and quasi-static loadings.
- Only a single anchor is considered.
- For non-cracked concrete only.

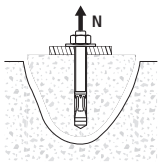


ANCHOR SIZE		M10	M12	M16	M20	M24
$N_{Rd,s}$	[kN]					
~ Carbon Steel		19.3	28.1	52.3	81.7	117.7
~ Stainless Steel		21.7	31.6	58.8	91.7	132.1

The design steel tensile resistance is derived from $N_{Rd,s} = N_{Rk,s} / \gamma_{Ms,N}$ where the partial safety factor is 1.5 for carbon steel and 1.87 for stainless steel. The recommended load is derived from $N_{Rec,s} = N_{Rd,s} / \gamma_F$ where the partial safety factor is 1.4.

CONCRETE CONE / PULL-OUT RESISTANCE [$N_{Rd,c}$]

- For static and quasi-static loadings.
- For non-cracked concrete only.
- Only a single anchor is considered.
- No anchor spacing and edge distance influences.
- Concrete compressive strength C20/25 ($f_{ck,cube}$ = 25 N/mm²).
- Loading applicable to both carbon steel and stainless steel anchor.



ANCHOR SIZE		M10 x 45	M12 x 55	M12 x 70	M16 x 70	M16 x 95	M20 x 70	M20 x 95	M24 x 95	M24 x 120
h_{ef}	[mm]	33	40	55	50	75	50	75	70	95
$N^0_{Rd,c}$	[kN]	9.0	12.1	17.4	21.5	34.0	23.4	37.0	46.3	61.3

The design concrete cone resistance is derived from $N^0_{Rd,c} = N^0_{Rk,c} / \gamma_{Mc,N}$ where partial safety factor is 1.5. The recommended load is derived from $N^0_{Rec,c} = N^0_{Rd,c} / \gamma_F$ where the partial safety factor is 1.4.

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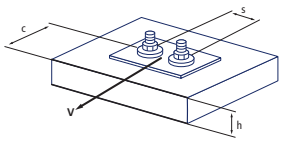
SHEAR LOAD [V_{Rd}]

Design Shear Resistance, V_{Rd}: lower value of [$V_{Rd,s}$; $V_{Rd,c}$; $V_{Rd,cp}$]

Design Steel Shear Resistance: $V_{Rd,s}$

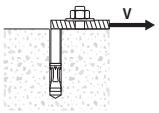
Design Concrete Edge Shear Resistance: $V_{Rd,c} = V^0_{Rd,c} * \Psi_{\beta,V} * \Psi_{\alpha,V} * \Psi_{sc,V}$

Design Concrete Pry-Out Resistance: $V_{Rd,cp} = V^0_{Rd,cp} * \Psi_{\beta,V} * \Psi_{s,N} * \Psi_{c,N}$



STEEL SHEAR RESISTANCE [$V_{Rd,s}$]

- For static and quasi-static loadings.
- Only a single anchor is considered.
- For non-cracked concrete only.

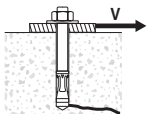


ANCHOR SIZE		M10	M12	M16	M20	M24
$V_{Rd,s}$	[kN]					
~ Carbon Steel		13.9	20.2	37.7	58.8	84.7
~ Stainless Steel		15.6	22.7	42.3	66.0	95.0

The design steel shear resistance is derived from $V_{Rd,s} = V_{Rk,s} / \gamma_{Ms,v}$ where the partial safety factor is 1.25 for carbon steel and 1.56 for stainless steel. The recommended load is derived from $V_{Rec,s} = V_{Rd,s} / \gamma_F$ where the partial safety factor is 1.4.

CONCRETE EDGE SHEAR RESISTANCE [$V_{Rd,c}$]

- For non-cracked concrete.
- Only a single anchor is considered.
- No anchor spacing and edge distance influences.
- Single embedded depth is used for loading tabulation.
- Concrete compressive strength C20/25 ($f_{ck,cube}$ = 25 N/mm²).
- Loading applicable to both carbon steel and stainless steel anchor.

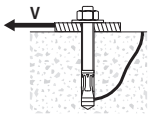


ANCHOR SIZE		M10 x 45	M12 x 55	M12 x 70	M16 x 70	M16 x 95	M20 x 70	M20 x 95	M24 x 95	M24 x 120
h_{ef}	[mm]	33	40	55	50	75	50	75	70	95
c_{min}	[mm]	33	40	55	50	75	50	75	70	95
$V^0_{Rd,c}$	[kN]	3.4	4.7	7.6	7.5	13.8	8.5	15.6	15.0	23.7

The design concrete edge shear resistance is derived from $V^0_{Rd,c} = V^0_{Rk,c} / \gamma_{Mc,V}$ where the partial safety factor is 1.5. The recommended load is derived from $V^0_{Rec,c} = V^0_{Rd,c} / \gamma_F$ where the partial safety factor is 1.4.

CONCRETE PRY-OUT RESISTANCE [$V_{Rd,cp}$]

- For non-cracked concrete.
- Only a single anchor is considered.
- No anchor spacing and edge distance influences.
- Single embedded depth is used for loading tabulation.
- Concrete compressive strength C20/25 ($f_{ck,cube}$ = 25 N/mm²).
- Loading applicable to both carbon steel and stainless steel anchor.



ANCHOR SIZE		M10 x 45	M12 x 55	M12 x 70	M16 x 70	M16 x 95	M20 x 70	M20 x 95	M24 x 95	M24 x 120
h_{ef}	[mm]	33	40	55	50	75	50	75	70	95
$V^0_{Rd,cp}$	[kN]	9.0	12.1	17.4	21.5	68.0	23.4	74.0	92.6	122.6

The design concrete pry-out resistance is derived from $V^0_{Rd,cp} = V^0_{Rk,cp} / \gamma_{Mp,v}$ where the partial safety factor is 1.5. The recommended load is derived from $V^0_{Rec,cp} = V^0_{Rd,cp} / \gamma_F$ where the partial safety factor is 1.4.

COMBINED TENSION & SHEAR

Combined Tension & Shear: $\frac{N_{Sd}}{N_{Rd}} + \frac{V_{Sd}}{V_{Rd}} \leq 1.2$

The resultant force must be satisfied with the above conditions. The designer must cross check the loading conditions, types of applied loads and substrate to ensure the recommended anchor is applicable to the actual site applications. This would avoid any design faults which commonly caused by inconclusive load requirements with respective to actual site conditions.

INFLUENCING FACTORS - TENSION

INFLUENCE OF CONCRETE STRENGTH ON PULL-OUT AND CONCRETE CONE RESISTANCE [$\Psi_{\beta,N}$]

$$\Psi_{\beta,N} = \sqrt{\frac{f_{ck,cube}}{25}}$$

Limits: 25 MPa $\leq f_{ck,cube} \leq$ 60 MPa

Concrete Strength Designation (ENV 206)		C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 50/60
Concrete Cylinder Strength, $f_{ck,cyl}$	[MPa]	20	25	30	35	40	50
Concrete Cube Strength, $f_{ck,cube}$	[MPa]	25	30	37	45	50	60
Concrete Strength Factor, $\Psi_{\beta,N}$		1.00	1.10	1.22	1.34	1.41	1.55

INFLUENCE OF ANCHOR SPACING [$\Psi_{s,N}$]

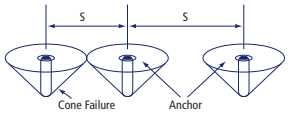
Anchor Spacing 's' [mm]	Effective Depth [mm]						
	33	40	50	55	70	75	95
33	0.67						
40	0.70	0.67					
50	0.75	0.71	0.67				
55	0.78	0.73	0.68	0.67			
70	0.85	0.79	0.73	0.71	0.67		
75	0.88	0.81	0.75	0.73	0.68	0.67	
95	0.98	0.90	0.82	0.79	0.73	0.71	0.67
99	1.00	0.91	0.83	0.80	0.74	0.72	0.67
120		1.00	0.90	0.86	0.79	0.77	0.71
150			1.00	0.95	0.86	0.83	0.76
165				1.00	0.89	0.87	0.79
210					1.00	0.97	0.87
225						1.00	0.89
285							1.00
Critical Spacing 's_{cr}' [mm]	99	120	150	165	210	225	285
Minimum Spacing 's_{min}' [mm]	33	40	50	55	70	75	95

$$\Psi_{s,N} = 0.5 + \frac{s}{6 * h_{ef}}$$

Limits: $s_{min} \leq s \leq s_{cr}$

$s_{min} = 1.0 * h_{ef}$

$s_{cr} = 3.0 * h_{ef}$



INFLUENCE OF EDGE DISTANCE [$\Psi_{c,N}$]

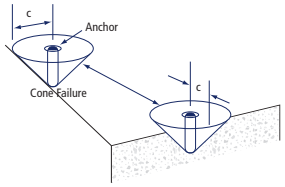
Edge Distance 'c' [mm]	Effective Depth [mm]						
	33	40	50	55	70	75	95
33	0.76						
40	0.86	0.76					
50	1.00	0.88	0.76				
55		0.94	0.81	0.76			
60		1.00	0.85	0.80			
70			0.95	0.89	0.76		
75			1.00	0.93	0.79	0.76	
83				1.00	0.85	0.81	
95					0.93	0.89	0.76
105					1.00	0.95	0.81
113						1.00	0.85
143							1.00
Critical Edge Distance 'c_{cr}' [mm]	50	60	75	83	105	113	143
Minimum Edge Distance 'c_{min}' [mm]	33	40	50	55	70	75	95

$$\Psi_{c,N} = 0.29 + 0.47 * \frac{c}{h_{ef}}$$

Limits: $c_{min} \leq c \leq c_{cr}$

$c_{min} = 1.0 * h_{ef}$

$c_{cr} = 1.5 * h_{ef}$



INFLUENCING FACTORS - SHEAR

INFLUENCE OF CONCRETE STRENGTH ON CONCRETE EDGE SHEAR AND CONCRETE PRY-OUT RESISTANCE [$\Psi_{\beta,V}$]

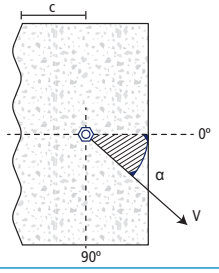
$$\Psi_{\beta,V} = \sqrt{\frac{f_{ck,cube}}{25}}$$

Limits: 25 MPa $\leq f_{ck,cube} \leq$ 60 MPa

Concrete Strength Designation (ENV 206)		C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 50/60
Concrete Cylinder Strength, $f_{ck,cyl}$	[MPa]	20	25	30	35	40	50
Concrete Cube Strength, $f_{ck,cube}$	[MPa]	25	30	37	45	50	60
Concrete Strength Factor, $\Psi_{\beta,V}$		1.00	1.10	1.22	1.34	1.41	1.55

INFLUENCE OF SHEAR LOAD DIRECTION [$\Psi_{\alpha,V}$]

Load Type	Angle, α [°]	$\Psi_{\alpha,V}$
Oblique 0°	0° < α ≤ 15°	1.00
Oblique 30°	15° < α ≤ 37.5°	1.14
Oblique 45°	37.5° < α ≤ 52.5°	1.35
Oblique 60°	52.5° < α ≤ 67.5°	1.71
Oblique 90°	67.5° < α ≤ 90°	2.00

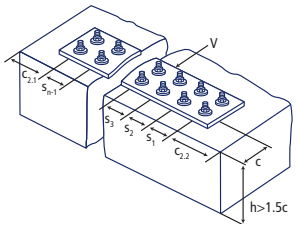


INFLUENCE OF ANCHOR SPACING AND EDGE DISTANCE ON CONCRETE EDGE SHEAR RESISTANCE [$\Psi_{sc,V}$]

$$\Psi_{sc,V} = \frac{c}{c_{min}} * \sqrt{\frac{c}{c_{min}}}$$ for single anchor towards a concrete edge

$$\Psi_{sc,V} = \frac{3c + s}{6c_{min}} * \sqrt{\frac{c}{c_{min}}}$$ for two anchors when $s \leq 3c$

$$\Psi_{sc,V} = \frac{3c + s_1 + s_2 + s_{n-1}}{3nc_{min}} * \sqrt{\frac{c}{c_{min}}}$$ for multiple anchors when s_1 to $s_{n-1} \leq 3c$ and $c_2 \geq 1.5c$



$\Psi_{sc,V}$		c / c_{min}															
		1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
Edge influence with single anchor		1.00	1.31	1.66	2.02	2.41	2.83	3.26	3.72	4.19	4.69	5.20	5.72	6.27	6.83	7.41	8.00
s / c_{min}	1.0	0.67	0.84	1.03	1.22	1.43	1.65	1.88	2.12	2.36	2.62	2.89	3.16	3.44	3.73	4.03	4.33
	1.5	0.75	0.93	1.12	1.33	1.54	1.77	2.00	2.25	2.50	2.76	3.03	3.31	3.60	3.89	4.19	4.50
	2.0	0.83	1.02	1.22	1.43	1.65	1.89	2.13	2.38	2.63	2.90	3.18	3.46	3.75	4.05	4.35	4.67
	2.5	0.92	1.11	1.32	1.54	1.77	2.00	2.25	2.50	2.77	3.04	3.32	3.61	3.90	4.21	4.52	4.83
	3.0	1.00	1.20	1.42	1.64	1.88	2.12	2.37	2.63	2.90	3.18	3.46	3.76	4.06	4.36	4.68	5.00
	3.5		1.30	1.52	1.75	1.99	2.24	2.50	2.76	3.04	3.32	3.61	3.91	4.21	4.52	4.84	5.17
	4.0			1.62	1.86	2.10	2.36	2.62	2.89	3.17	3.46	3.75	4.05	4.36	4.68	5.00	5.33
	4.5				1.96	2.21	2.47	2.74	3.02	3.31	3.60	3.90	4.20	4.52	4.84	5.17	5.50
	5.0					2.33	2.59	2.87	3.15	3.44	3.74	4.04	4.35	4.67	5.00	5.33	5.67
	5.5						2.71	2.99	3.28	3.57	3.88	4.19	4.50	4.82	5.15	5.49	5.83
	6.0						2.83	3.11	3.41	3.71	4.02	4.33	4.65	4.98	5.31	5.65	6.00
	6.5							3.24	3.53	3.84	4.16	4.47	4.80	5.13	5.47	5.82	6.17
	7.0								3.67	3.98	4.29	4.62	4.95	5.29	5.63	5.98	6.33
	7.5									4.11	4.43	4.76	5.10	5.44	5.79	6.14	6.50
	8.0										4.57	4.91	5.25	5.59	5.95	6.30	6.67
	8.5											5.05	5.40	5.75	6.10	6.47	6.83
	9.0											5.20	5.55	5.90	6.26	6.63	7.00
	9.5												5.69	6.05	6.42	6.79	7.17
	10.0													6.21	6.58	6.95	7.33
	10.5														6.74	7.12	7.50
	11.0															7.28	7.67
	11.5																7.83
	12.0																8.00