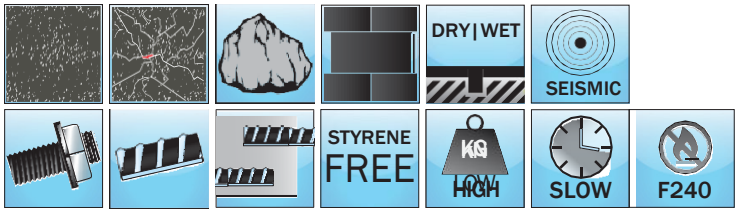
TSIRCON CO LTD

MANUFACTURERS & TRADERS
OF BUILDING MATERIALS

TSIRCO-RES 341G

Product Information



European Technical Assessment
ETAG 001 Parts 1 & 5 Option 1
Anchoring in concrete
ETA-14/0042

European Technical Assessment
According to TR023
Post-installed rebar connections
ETA-14/0237

Certified to NSF/ANSI 61 by IAPMO R&T (file N-7858)

Description

TSIRCO-RES 341G is a two-component 1:1 ratio pure epoxy bonded anchoring system for use in cracked and uncracked concrete under normal as well as seismic conditions (seismic category C1). Designed for most demanding structural applications and rebar connections, TSIRCO-RES 341G offers a very high load-bearing capacity.

Shelf Life

Cartridges should be stored in their original packaging, the correct way up and in cool dry conditions (+10°C to +25°C) out of direct sunlight. When stored correctly, the shelf life will be for 24 months from the date of manufacture.

Health & Safety

For health and safety information please refer to the relevant Safety Data Sheet.

Base Materials

- Cracked concrete
- Uncracked concrete
- Hard natural stone
- Solid rock
- Solid masonry

Approvals & Tests

- ETA according ETAG 001 Part 1 & 5 Option 1 for anchoring of threaded bars into cracked & uncracked concrete
- ETA according to TR023 for post-installed rebar connections
- Tested according to LEED 2009 EQ c4.1, SCAQMD rule 1168 (2005)
- Certified to NSF/ANSI-61 for contact with potable water
- Fire resistance F240 for reinforcing bars

Features

- Fixings close to free edges
- Fire tested
- Versatile
- Anchoring without expansion pressure
- High load capacities
- Available in side-by-side cartridges (400, 600, 1500ml) and UVL cartridges (250ml)
- Component volume ratio of 1:1
- Extended gel/open time

Accessories

- Applicators
- Mixing nozzles
- Air lance
- Cleaning brushes
- High flow mixing nozzles
- Extension tubes
- Resin stoppers

Uses/Applications

- Structural applications in cracked and uncracked concrete applications in seismic zones (C1)
- Façades
- Post installed rebar connections
- Crash barriers
- Structural steel

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

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Product Data Sheet

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Head office:
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P.O. Box 23863, 1687 Nicosia, CYPRUS.
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TSIRCO-RES 341G Working & Loading Times

Resin cartridge Temperature	T Work	Base Material Temperature	T Load
+10 to +15°C	20 mins	+5 to +10°C	24 hrs
		+10 to +15°C	12 hrs
+15 to +20°C	15 mins	+15 to +20°C	8 hrs
+20 to +25°C	11 mins	+20 to +25°C	7 hrs
+25 to +30°C	8 mins	+25 to +30°C	6 hrs
+30 to +35°C	6 mins	+30 to +35°C	5 hrs
+35 to +40°C	4 mins	+35 to +40°C	4 hrs
+40°C	3 mins	+40°C	3 hrs
Prior use ensure cartridge temperature is > 10°C			

Note: T Work is typical gel time at highest base material temperature in the range. T Load is minimum set time required until load can be applied at the lowest base material temperature in the range.

Physical Properties

Property		Unit	Value	Test Standard
Density		g/cm^3	1.5	ASTM D 1875 @ +20°C / +72°F
Compressive Strength	24 hours	N/mm^2	75	ASTM D 695 @ +20°C / +72°F
	7 days	N/mm^2	95	
Tensile Strength	24 hours	N/mm^2	18	ASTM D 638 @ +20°C / +72°F
	7 days	N/mm^2	23	
Elongation at Break	24 hours	%	6.6	ASTM D 638 @ +20°C / +72°F
	7 days		5.9	
Tensile Modulus	24 hours	GN/m^2	5.7	ASTM D 638 @ +20°C / +72°F
	7 days	GN/m^2	5.5	
Flexural Strength	24 hours	N/mm^2	45	ASTM D 790 @ +20°C / +72°F
HDT	7 days	°C	49	ASTM D 648 @ +20°C / +72°F
VOC		g/L	4.5	ASTM D 2369

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Chemical Resistance

The chemical mortar has undergone extensive chemical resistance testing. The results are summarised in the table below.

Chemical Environment	Concentration	Result
Aqueous Solution Acetic Acid	10%	C
Acetone	100%	×
Aqueous Solution Aluminium Chloride	Saturated	✓
Aqueous Solution Aluminium Nitrate	10%	✓
Ammonia Solution	5%	✓
Jet Fuel	100%	C
Benzene	100%	C
Benzoic Acid	Saturated	✓
Benzyl Alcohol	100%	×
Sodium Hypochlorite Solution	5 - 15%	✓
Butyl Alcohol	100%	C
Calcium Sulphate Aqueous Solution	Saturated	✓
Carbon Monoxide	Gas	✓
Carbon Tetrachloride	100%	C
Chlorine Water	Saturated	×
Chloro Benzene	100%	×
Citric Acid Aqueous Solution	Saturated	✓
Cyclohexanol	100%	✓
Diesel Fuel	100%	C
Diethylene Glycol	100%	✓
Ethanol	95%	×
Ethanol Aqueous Solution	20%	C
Heptane	100%	C

Chemical Environment	Concentration	Result
Hexane	100%	C
Hydrochloric Acid	10%	✓
	15%	✓
	25%	C
Hydrogen Sulphide Gas	100%	✓
Isoproyl Alcohol	100%	×
Linseed Oil	100%	✓
Lubricating Oil	100%	✓
Mineral Oil	100%	✓
Paraffin / Kerosene (Domestic)	100%	C
Phenol Aqueous Solution	1%	C
Phosphoric Acid	50%	✓
Potassium Hydroxide	10% / pH13	✓
Sea Water	100%	C
Styrene	100%	C
Sulphur Dioxide Solution	10%	✓
Sulphur Dioxide (40°C)	5%	✓
Sulphuric Acid	10%	✓
	50%	✓
Turpentine	100%	C
White Spirit	100%	✓
Xylene	100%	C

✓ = Resistant to 75°C with at least 80% of physical properties retained.

C = Contact only to a maximum of 25°C.

× = Not Resistant

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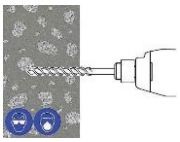
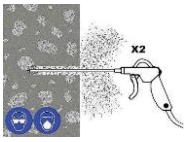
Solid Substrate Installation Method

Before commencing installation ensure the operative is equipped with appropriate personal protection equipment, SDS Hammer Drill, Air, Hole Cleaning Brush, good quality Dispensing Tool – either manual or power operated, Chemical cartridge with mixing nozzle and extension tube, if needed.

1. Using the SDS Hammer Drill in rotary hammer mode for drilling, with a carbide tipped drill bit of the appropriate size, drill the hole to the specified hole diameter and depth.

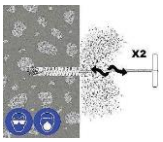


2. Insert the Air Lance to the bottom of the hole and depress the trigger for 2 seconds. The compressed air must be clean – free from water and oil – and at a minimum pressure of 6bar.



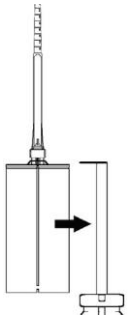
Perform the blowing operation twice.

3. Select the correct size Hole Cleaning Brush. Ensure that the brush is in good condition and the correct diameter. Insert the brush to the bottom of the hole, using a brush extension if needed to reach the bottom of the hole and withdraw with a twisting motion. *There should be positive interaction between the steel bristles of the brush and the sides of the drilled hole.*



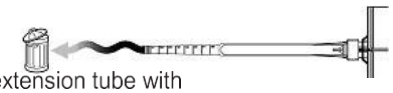
Perform the brushing operation twice.

4. Repeat 2
5. Repeat 3
6. Repeat 2
7. Select the appropriate static mixer nozzle, checking that the mixing elements are present and correct **(do not modify the mixer)**. Attach mixer nozzle to the cartridge. Check the Dispensing Tool is in good working order. Place the cartridge into the dispensing tool.

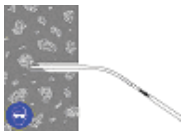


Note: The QH nozzle is in two sections. One section contains the mixing elements and the other section is an extension piece. Connect the extension piece to the mixing section by pushing the two sections firmly together until a positive engagement is felt.

8. Extrude some resin to waste until an even-colored mixture is extruded, The cartridge is now ready for use

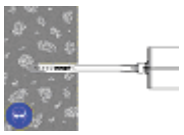


9. Attach an extension tube with resin stopper (if required) to the end of the mixing nozzle with a push fit



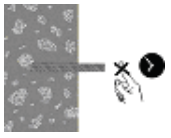
(The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal thread).

10. Insert the mixing nozzle to the bottom of the hole. Extrude the resin and slowly withdraw the nozzle from the hole. **Ensure no air voids are created** as the nozzle is withdrawn. Inject resin until the hole is approximately ¾ full and remove the nozzle from the hole.



11. Select the steel anchor element ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the steel element into the hole using a back and forth twisting motion to ensure complete cover, until it reaches the bottom of the hole. Excess resin will be expelled from the hole evenly around the steel element and there shall be no gaps between the anchor element and the wall of the drilled hole.

12. Clean any excess resin from around the mouth of the hole.
13. Do not disturb the anchor until at least the minimum cure time has elapsed. Refer to the Working and Load Timetable to determine the appropriate cure time.



14. Position the fixture and tighten the anchor to the appropriate installation torque.

Do not over-torque the anchor as this could adversely affect its performance.

Head office:
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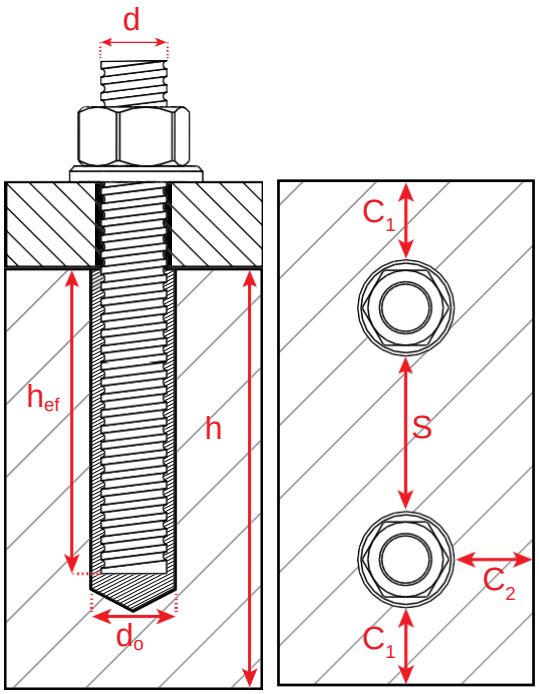
Installation parameters

Threaded rods

Size			M10	M12	M16	M20	M24	M30
Nominal drill hole diameter	$Ød_0$	[mm]	12	14	18	22	26	35
Diameter of cleaning brush	d_b	[mm]	S14H/F	S16H/F	S22H/F	S24H/F	S31H/F	S38H/F
Torque moment	T_{inst}	[Nm]	20	40	80	135	200	270
Min. embedment depth								
Depth of drill hole	h_0	[mm]	60	70	80	90	96	120
Effective anchorage depth	h_{ef}	[mm]	60	70	80	90	96	120
Minimum edge distance	c_{min}	[mm]	40	40	45	50	55	65
Minimum spacing	s_{min}	[mm]	40	40	45	50	55	65
Minimum thickness of member	h_{min}	[mm]	100	100	115	130	160	200
Max. embedment depth								
Depth of drill hole	h_0	[mm]	200	240	320	400	480	600
Effective anchorage depth	h_{ef}	[mm]	200	240	320	400	480	600
Minimum edge distance	c_{min}	[mm]	40	40	45	50	55	65
Minimum spacing	s_{min}	[mm]	40	40	45	50	55	65
Minimum thickness of member	h_{min}	[mm]	224	268	336	444	532	670

Reinforcing bars

Size			Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Nominal drill hole diameter	$Ød_0$	[mm]	14	16	20	25	32	40
Diameter of cleaning brush	d_b	[mm]	S16H/F	S18H/F	S22H/F	S27H/F	S35H/F	S43H/F
Torque moment	T_{inst}	[Nm]	20	40	80	135	200	270
Min. embedment depth								
Depth of drill hole	h_0	[mm]	60	70	80	90	100	128
Effective anchorage depth	h_{ef}	[mm]	60	70	80	90	100	128
Minimum edge distance	c_{min}	[mm]	40	40	45	50	55	65
Minimum spacing	s_{min}	[mm]	40	40	45	50	55	65
Minimum thickness of member	h_{min}	[mm]	100	100	120	140	164	208
Max. embedment depth								
Depth of drill hole	h_0	[mm]	200	240	320	400	500	640
Effective anchorage depth	h_{ef}	[mm]	200	240	320	400	500	640
Minimum edge distance	c_{min}	[mm]	40	40	45	50	55	65
Minimum spacing	s_{min}	[mm]	40	40	45	50	55	65
Minimum thickness of member	h_{min}	[mm]	228	272	360	450	564	720



Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
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Steel Failure Information - Threaded Bars
Characteristic resistance values to tension load

Steel Failure - Characteristic resistance								
Size			M10	M12	M16	M20	M24	M30
Steel grade 5.8	$N_{Rk,s}$	[kN]	29	42	79	123	177	281
Partial safety factor	γ_{Ms}	[-]	1.5					
Steel grade 8.8	$N_{Rk,s}$	[kN]	46	67	126	196	282	449
Partial safety factor	γ_{Ms}	[-]	1.5					
Steel grade 10.9*	$N_{Rk,s}$	[kN]	58	84	157	245	353	561
Partial safety factor	γ_{Ms}	[-]	1.4					
Stainless steel grade A4-70	$N_{Rk,s}$	[kN]	41	59	110	172	247	393
Partial safety factor	γ_{Ms}	[-]	1.9					
Stainless steel grade A4-80	$N_{Rk,s}$	[kN]	46	67	126	196	282	449
Partial safety factor	γ_{Ms}	[-]	1.6					
Stainless steel grade 1,4529	$N_{Rk,s}$	[kN]	41	59	110	172	247	393
Partial safety factor	γ_{Ms}	[-]	1.5					

**Galvanized rod of high strength are sensitive to hydrogen induced brittle failure.*

Steel Failure Information - Reinforcing bars
Characteristic resistance values to tension load

Steel Failure - Characteristic resistance								
Size			Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Rebar BSt 500 S	$N_{Rk,s}$	[kN]	43	62	111	173	270	442
Partial safety factor	γ_{Ms}	[-]	1.4					

Using TSIRCO-RES 341G with Threaded Bars
Combined pullout and concrete cone failure in uncracked concrete C20/25

Size				M10	M12	M16	M20	M24	M30
Characteristic bond resistance in uncracked concrete									
Characteristic bond resistance dry/wet concrete		τ_{Rk}	[N/mm²]	11	11	11	11	12	10
Partial safety factor		γ_{Mc}	[-]	1.8	2.1				
Factor for concrete	C30/37		ψ_c	1.12					
	C40/45			1.23					
	C50/60			1.30					

Splitting failure

Size			M10	M12	M16	M20	M24	M30
Edge distance	[mm]		$1.0 * h_{ef} \leq 2.0 * h_{ef} * \left(2.5 - \frac{}{h_{ef}}\right) \leq 2.4 * h_{ef}$					
Spacing	[mm]		$2 \cdot C_{cr,sp}$					
Partial safety factor	γ_{Msp}	[-]	1.8					

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Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at various embedment depths

using threaded rods in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Effective Embedment Depth = MIN	h_{ef}	mm	60	70	80	90	96	120
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	20.73	29.03	44.23	62.20	86.86	113.10
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 6d	h_{ef}	mm	60	72	96	120	144	180
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	20.73	29.86	53.08	82.94	130.29	169.65
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 8d	h_{ef}	mm	80	96	128	160	192	240
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	27.65	39.81	70.77	110.58	173.72	226.19
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 10d	h_{ef}	mm	100	120	160	200	240	300
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	34.56	49.76	88.47	138.23	217.15	282.74
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = STD	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	31.10	45.62	70.77	117.50	190.00	282.74
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 12d	h_{ef}	mm	120	144	192	240	288	360
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	41.47	59.72	106.16	165.88	260.58	339.29
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 14d	h_{ef}	mm	140	168	224	280	336	420
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	48.38	69.67	123.85	193.52	304.01	395.84
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 16d	h_{ef}	mm	160	192	256	320	384	480
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	55.29	79.62	141.55	221.17	347.44	452.39
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 18d	h_{ef}	mm	180	216	288	360	432	540
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	62.20	89.57	159.24	248.81	390.86	508.94
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 20d	h_{ef}	mm	200	240	320	400	480	600
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	69.12	99.53	176.93	276.46	434.29	565.49
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10

[1] Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.

[2] Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.

[3] Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).

[4] Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.

[5] Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.

[6] The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.

[7] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.

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Tension load calculations for combined concrete cone & pullout failure at Min embedment depth

using threaded rods in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Nominal Anchor Diameter	d	mm	10	12	16	20	24	30
Characteristic Bond Strength	τ_{Rk}	N/mm²	11.00	11.00	11.00	11.00	12.00	10.00
Effective Embedment Depth	h_{ef}	mm	60	70	80	90	96	120
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	20.73	29.03	44.23	62.20	86.86	113.10
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	120	140	160	180	192	240
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	60	70	80	90	96	120
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	180	210	240	270	288	360
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	90	105	120	135	144	180

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
30	0.53					
35	0.57	0.53				
40	0.6	0.56	0.53			
45	0.64	0.59	0.56	0.53		
50	0.67	0.62	0.58	0.56	0.54	
60	0.75	0.68	0.64	0.6	0.58	0.53
70	0.83	0.75	0.69	0.65	0.63	0.57
80	0.91	0.82	0.75	0.7	0.67	0.6
90	N/R	0.89	0.81	0.75	0.72	0.64
100		0.96	0.87	0.8	0.77	0.67
105		N/R	0.9	0.83	0.79	0.69
110			0.93	0.86	0.82	0.71
115			0.97	0.88	0.84	0.73
120			N/R	0.91	0.87	0.75
125				0.94	0.9	0.77
130				0.97	0.92	0.79
135				N/R	0.95	0.81
140					0.98	0.83
144					N/R	0.85
145						0.85
150						0.87
155						0.89
160						0.91
165						0.93
170						0.96
175						0.98
180						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
30	0.61					
35	0.62	0.59				
40	0.63	0.6	0.58			
45	0.65	0.61	0.59	0.58		
50	0.66	0.62	0.6	0.59	0.59	
60	0.69	0.65	0.63	0.61	0.6	0.58
70	0.71	0.67	0.65	0.63	0.62	0.6
80	0.74	0.69	0.67	0.65	0.64	0.61
90	0.76	0.72	0.69	0.67	0.66	0.63
100	0.79	0.74	0.71	0.69	0.67	0.64
110	0.82	0.76	0.73	0.7	0.69	0.65
120	0.84	0.79	0.75	0.72	0.71	0.67
130	0.87	0.81	0.77	0.74	0.73	0.68
140	0.9	0.83	0.79	0.76	0.74	0.69
150	0.92	0.86	0.81	0.78	0.76	0.71
160	0.95	0.88	0.83	0.8	0.78	0.72
170	0.97	0.91	0.85	0.81	0.8	0.74
180	N/R	0.93	0.88	0.83	0.81	0.75
190		0.95	0.9	0.85	0.83	0.76
200		0.98	0.92	0.87	0.85	0.78
210		N/R	0.94	0.89	0.86	0.79
220			0.96	0.91	0.88	0.81
240			N/R	0.94	0.92	0.83
260				0.98	0.95	0.86
270				N/R	0.97	0.88
280					0.99	0.89
288					N/R	0.90
300						0.92
350						0.99
360						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at Std embedment depth

using threaded rods in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Nominal Anchor Diameter	d	mm	10	12	16	20	24	30
Characteristic Bond Strength	τ_{Rk}	N/mm²	11.00	11.00	11.00	11.00	12.00	10.00
Effective Embedment Depth	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	31.10	45.62	70.77	117.50	190.00	282.74
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	180	220	256	340	420	600
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	90	110	128	170	210	300
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	242	291	384	484	607	693
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	121	145	192	242	304	346

1. *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
2. *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
3. *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
4. *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
5. *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
6. *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
7. *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
8. *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
45	0.56					
50	0.58					
55	0.61	0.56				
60	0.63	0.58				
65	0.66	0.6	0.54			
70	0.69	0.63	0.55			
80	0.75	0.67	0.58			
85	0.77	0.69	0.6	0.54		
90	0.8	0.72	0.62	0.56		
100	0.87	0.77	0.65	0.58		
105	0.9	0.79	0.67	0.59	0.54	
110	0.93	0.81	0.69	0.61	0.55	
121	N/R	0.87	0.72	0.64	0.57	
130		0.92	0.76	0.66	0.59	
140		0.97	0.79	0.69	0.61	
145		N/R	0.81	0.7	0.62	
150			0.83	0.72	0.63	0.59
160			0.87	0.75	0.66	0.61
170			0.91	0.77	0.68	0.63
180			0.95	0.8	0.7	0.65
192			N/R	0.84	0.73	0.67
200				0.87	0.74	0.69
220				0.93	0.79	0.73
242				N/R	0.84	0.77
260					0.89	0.81
280					0.94	0.85
300					0.99	0.90
304					N/R	0.90
320						0.94
346						N/R

1. *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
2. *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
3. *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
4. *Interpolation is allowed.*
5. *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
6. *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
45	0.65					
50	0.66					
55	0.66	0.64				
60	0.67	0.64				
65	0.68	0.65	0.59			
70	0.69	0.66	0.6			
80	0.71	0.68	0.61			
85	0.72	0.68	0.62	0.59		
90	0.73	0.69	0.62	0.59		
100	0.75	0.71	0.64	0.6		
105	0.76	0.71	0.64	0.61	0.59	
125	0.79	0.75	0.67	0.63	0.6	
150	0.84	0.78	0.7	0.65	0.62	0.61
175	0.88	0.82	0.73	0.68	0.64	0.63
200	0.93	0.86	0.76	0.71	0.66	0.64
225	0.97	0.9	0.8	0.73	0.69	0.66
242	N/R	0.93	0.82	0.75	0.7	0.67
250		0.94	0.83	0.76	0.71	0.68
275		0.98	0.86	0.78	0.73	0.7
291		N/R	0.88	0.8	0.74	0.71
300			0.89	0.81	0.75	0.72
350			0.96	0.86	0.79	0.75
384			N/R	0.9	0.82	0.78
400				0.91	0.83	0.79
450				0.96	0.87	0.82
484				N/R	0.9	0.85
500					0.91	0.86
550					0.95	0.90
607					N/R	0.94
693						N/R

1. *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
2. *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
3. *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
4. *Interpolation is allowed.*
5. *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
6. *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at 20d embedment depth

using threaded rods in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Nominal Anchor Diameter	d	mm	10	12	16	20	24	30
Characteristic Bond Strength	τ_{Rk}	N/mm²	11.00	11.00	11.00	11.00	12.00	10.00
Effective Embedment Depth	h_{ef}	mm	200	240	320	400	480	600
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	69.12	99.53	176.93	276.46	434.29	565.49
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	400	480	640	800	960	1200
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	200	240	320	400	480	600
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	242	291	388	484	607	693
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	121	145	194	242	304	346

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
100	0.87					
110	0.93					
120	0.99	0.87				
121	N/R	0.87				
130		0.92				
140		0.97				
145		N/R				
150						
160			0.87			
170			0.9			
180			0.94			
190			0.98			
194			N/R			
200				0.87		
210				0.9		
220				0.93		
230				0.96		
240				0.99	0.84	
242				N/R	0.84	
250					0.86	
260					0.89	
270					0.91	
280					0.94	
290					0.96	
300					0.99	0.9
310					N/R	0.92
320						0.94
330						0.96
340						0.99
346						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
100	0.78					
120	0.81	0.77				
140	0.84	0.8				
160	0.87	0.83	0.76			
180	0.9	0.85	0.78			
200	0.94	0.88	0.8	0.75		
225	0.97	0.91	0.83	0.77		
240	0.99	0.93	0.85	0.79	0.73	
242	N/R	0.94	0.85	0.79	0.73	
275		0.98	0.88	0.82	0.75	
291		N/R	0.9	0.83	0.76	
300			0.91	0.84	0.77	0.75
325			0.94	0.86	0.79	0.77
350			0.96	0.88	0.81	0.78
375			0.99	0.91	0.83	0.8
388			N/R	0.92	0.84	0.81
400				0.93	0.85	0.81
425				0.95	0.86	0.83
450				0.97	0.88	0.85
475				0.99	0.9	0.86
484				N/R	0.91	0.87
500					0.92	0.88
525					0.94	0.89
550					0.96	0.91
575					0.98	0.93
600					0.99	0.94
607					N/R	0.95
650						0.97
693						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

Using TSIRCO-RES 341G with Threaded Bars

Combined pullout and concrete cone failure in cracked concrete C20/25

Size				M10	M12	M16	M20	M24	M30
Characteristic bond resistance in cracked concrete									
Characteristic bond resistance dry/wet concrete		τ_{Rk}	[N/mm²]	8.5	8.5	8.5	5.5	5.5	5.5
Partial safety factor		γ_{Mc}	[-]	1.8	2.1				
Factor for concrete	C30/37		ψ_c	1.03					
	C40/45			1.06					
	C50/60			1.07					

Splitting failure

Size			M10	M12	M16	M20	M24	M30
Edge distance	[mm]		$1.0 * h_{ef} \leq 2.0 * h_{ef} * \left(2.5 - \frac{h}{h_{ef}}\right) \leq 2.4 * h_{ef}$					
Spacing	[mm]		$2 \cdot C_{cr,sp}$					
Partial safety factor	γ_{Msp}	[-]	1.8					

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at various embedment depths

using threaded rods in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Effective Embedment Depth = MIN	h_{ef}	mm	60	70	80	90	96	120
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	16.02	22.43	34.18	31.10	39.81	62.20
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 6d	h_{ef}	mm	60	72	96	120	144	180
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	16.02	23.07	41.02	41.47	59.72	93.31
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 8d	h_{ef}	mm	80	96	128	160	192	240
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	21.36	30.76	54.69	55.29	79.62	124.41
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 10d	h_{ef}	mm	100	120	160	200	240	300
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	26.70	38.45	68.36	69.12	99.53	155.51
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = STD	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	24.03	35.25	54.69	58.75	87.08	155.51
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 12d	h_{ef}	mm	120	144	192	240	288	360
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	32.04	46.14	82.03	82.94	119.43	186.61
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 14d	h_{ef}	mm	140	168	224	280	336	420
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	37.38	53.83	95.71	96.76	139.34	217.71
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 16d	h_{ef}	mm	160	192	256	320	384	480
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	42.73	61.52	109.38	110.58	159.24	248.81
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 18d	h_{ef}	mm	180	216	288	360	432	540
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	48.07	69.22	123.05	124.41	179.15	279.92
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 20d	h_{ef}	mm	200	240	320	400	480	600
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	53.41	76.91	136.72	138.23	199.05	311.02
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10

[1] Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.

[2] Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.

[3] Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).

[4] Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.

[5] Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.

[6] The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.

[7] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.

Head office:
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P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at Min embedment depth

using threaded rods in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Nominal Anchor Diameter	d	mm	10	12	16	20	24	30
Characteristic Bond Strength	τ_{Rk}	N/mm²	8.50	8.50	8.50	5.50	5.50	5.50
Effective Embedment Depth	h_{ef}	mm	60	70	80	90	96	120
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	16.02	22.43	34.18	31.10	39.81	62.20
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	120	140	160	180	192	240
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	60	70	80	90	96	120
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	180	210	240	270	288	360
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	90	105	120	135	144	180

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
30	0.53					
35	0.57	0.53				
40	0.60	0.56	0.53			
45	0.64	0.59	0.56	0.53		
50	0.67	0.62	0.58	0.56	0.54	
60	0.75	0.68	0.64	0.6	0.58	0.53
70	0.83	0.75	0.69	0.65	0.63	0.57
80	0.91	0.82	0.75	0.70	0.67	0.6
90	N/R	0.89	0.81	0.75	0.72	0.64
100		0.96	0.87	0.8	0.77	0.67
105		N/R	0.90	0.83	0.79	0.69
110			0.93	0.86	0.82	0.71
115			0.97	0.88	0.84	0.73
120			N/R	0.91	0.87	0.75
125				0.94	0.90	0.77
130				0.97	0.92	0.79
135				N/R	0.95	0.81
140					0.98	0.83
144					0.99	0.85
145					N/R	0.85
150						0.87
155						0.89
160						0.91
165						0.93
170						0.96
175						0.98
180						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
30	0.59					
35	0.61	0.58				
40	0.62	0.6	0.58			
45	0.63	0.61	0.59	0.58		
50	0.65	0.62	0.6	0.59	0.59	
60	0.67	0.64	0.63	0.61	0.6	0.58
70	0.7	0.67	0.65	0.63	0.62	0.6
80	0.73	0.69	0.67	0.65	0.64	0.61
90	0.76	0.71	0.69	0.67	0.66	0.63
100	0.78	0.74	0.71	0.69	0.67	0.64
120	0.84	0.79	0.75	0.72	0.71	0.67
140	0.89	0.83	0.79	0.76	0.74	0.69
160	0.95	0.88	0.83	0.8	0.78	0.72
180	N/R	0.93	0.88	0.83	0.81	0.75
200		0.98	0.92	0.87	0.85	0.78
210		N/R	0.94	0.89	0.86	0.79
220			0.96	0.91	0.88	0.81
240			N/R	0.94	0.92	0.83
260				0.98	0.95	0.86
270				N/R	0.97	0.88
280					0.99	0.89
288					N/R	0.9
300						0.92
320						0.94
340						0.97
360						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at Std embedment depth

using threaded rods in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Nominal Anchor Diameter	d	mm	10	12	16	20	24	30
Characteristic Bond Strength	τ_{Rk}	N/mm²	8.50	8.50	8.50	5.50	5.50	5.50
Effective Embedment Depth	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	24.03	35.25	54.69	58.75	87.08	155.51
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	180	220	256	340	420	600
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	90	110	128	170	210	300
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	213	255	341	343	411	514
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	106	128	170	171	206	257

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
45	0.59					
50	0.62					
55	0.65	0.59				
60	0.68	0.62				
65	0.71	0.64	0.56			
70	0.74	0.67	0.58			
80	0.81	0.72	0.62			
85	0.84	0.75	0.64	0.64		
90	0.88	0.78	0.66	0.65		
100	0.95	0.83	0.70	0.69		
105	0.99	0.86	0.72	0.71	0.64	
106	N/R	0.87	0.72	0.72	0.65	
110		0.89	0.74	0.73	0.66	
120		0.95	0.78	0.77	0.69	
128		N/R	0.81	0.81	0.72	
130			0.82	0.82	0.73	
140			0.86	0.86	0.76	
150			0.91	0.90	0.79	0.69
160			0.95	0.95	0.83	0.72
170			N/R	0.99	0.87	0.75
171				N/R	0.87	0.75
180					0.90	0.77
190					0.94	0.80
200					0.98	0.83
206					N/R	0.85
220						0.89
240						0.95
257						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
45	0.65					
50	0.66					
55	0.67	0.64				
60	0.68	0.65				
65	0.69	0.66	0.60			
70	0.70	0.66	0.60			
80	0.72	0.68	0.62			
85	0.73	0.69	0.62	0.67		
90	0.74	0.70	0.63	0.68		
100	0.76	0.72	0.65	0.69		
105	0.78	0.73	0.65	0.70	0.67	
125	0.82	0.77	0.68	0.72	0.69	
150	0.87	0.81	0.72	0.76	0.72	0.68
175	0.92	0.86	0.76	0.79	0.74	0.70
200	0.97	0.90	0.79	0.82	0.77	0.72
213	N/R	0.92	0.81	0.84	0.79	0.73
225		0.95	0.83	0.85	0.80	0.74
250		0.99	0.87	0.88	0.83	0.77
255		N/R	0.87	0.89	0.83	0.77
275			0.90	0.92	0.85	0.79
300			0.94	0.95	0.88	0.81
341			N/R	0.99	0.92	0.85
343				N/R	0.93	0.85
350					0.93	0.86
400					0.99	0.90
411					N/R	0.91
450						0.94
500						0.99
514						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at 20d embedment depth

using threaded rods in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			M10	M12	M16	M20	M24	M30
Nominal Anchor Diameter	d	mm	10	12	16	20	24	30
Characteristic Bond Strength	τ_{Rk}	N/mm²	8.50	8.50	8.50	5.50	5.50	5.50
Effective Embedment Depth	h_{ef}	mm	200	240	320	400	480	600
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	53.41	76.91	136.72	138.23	199.05	311.02
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	400	480	640	800	960	1200
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	200	240	320	400	480	600
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	213	255	341	343	411	514
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	106	128	170	171	206	257

[1] Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.
[2] Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.
[3] Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.
[4] Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).
[5] Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.
[6] Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.
[7] The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.
[8] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
100	0.95					
106	N/R					
110						
120		0.95				
128		N/R				
130						
140						
150						
160			0.95			
170			N/R			
171						
180						
190						
200				N/R		
206						
210						
220						
230						
240					N/R	
250						
257						
260						
270						
280						
290						
300						N/R

[1] Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.
[2] Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.
[3] Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.
[4] Interpolation is allowed.
[5] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.
[6] Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	M10	M12	M16	M20	M24	M30
100	0.79					
120	0.83	0.79				
140	0.87	0.82				
160	0.91	0.85	0.78			
180	0.94	0.88	0.80			
200	0.98	0.92	0.83	0.84		
213	N/R	0.94	0.85	0.86		
220		0.95	0.85	0.87		
240		0.98	0.88	0.89	0.84	
255		N/R	0.90	0.91	0.85	
260			0.90	0.91	0.86	
280			0.93	0.93	0.88	
300			0.95	0.95	0.90	0.83
325			0.98	0.98	0.92	0.85
341			N/R	0.99	0.94	0.87
343				N/R	0.94	0.87
350					0.94	0.87
375					0.97	0.89
400					0.99	0.91
411					N/R	0.92
425						0.93
450						0.95
475						0.97
500						0.99
514						N/R

[1] Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.
[2] Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.
[3] Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.
[4] Interpolation is allowed.
[5] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.
[6] Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

Using TSIRCO-RES 341G with Reinforcing bars

Combined pullout and concrete cone failure in uncracked concrete C20/25

Size				Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Characteristic bond resistance in uncracked concrete									
Characteristic bond resistance dry/wet concrete		τ_{Rk}	[N/mm²]	11	11	12	12	12	12
Partial safety factor		γ_{Mc}	[-]	1.8	2.1				
Factor for concrete	C30/37		ψ_c	1.06					
	C40/45			1.11					
	C50/60			1.14					

Splitting failure

Size			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Edge distance	[mm]		$1.0 * h_{ef} \leq 2.0 * h_{ef} * \left(2.5 - \frac{h}{h_{ef}}\right) \leq 2.4 * h_{ef}$					
Spacing	[mm]		$2 \bullet C_{cr,sp}$					
Partial safety factor	γ_{Msp}	[-]	1.8					

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at various embedment depths

using reinforcing bars in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Effective Embedment Depth = MIN	h_{ef}	mm	60	70	80	90	100	128
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	20.73	29.03	48.25	67.86	94.25	154.42
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 6d	h_{ef}	mm	60	72	96	120	150	192
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	20.73	29.86	57.91	90.48	141.37	231.62
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 8d	h_{ef}	mm	80	96	128	160	200	256
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	27.65	39.81	77.21	120.64	188.50	308.83
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 10d	h_{ef}	mm	100	120	160	200	250	320
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	34.56	49.76	96.51	150.80	235.62	386.04
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = STD	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	31.10	45.62	77.21	128.18	197.92	361.91
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 12d	h_{ef}	mm	120	144	192	240	300	384
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	41.47	59.72	115.81	180.96	282.74	463.25
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 14d	h_{ef}	mm	140	168	224	280	350	448
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	48.38	69.67	135.11	211.12	329.87	540.45
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 16d	h_{ef}	mm	160	192	256	320	400	512
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	55.29	79.62	154.42	241.27	376.99	617.66
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 18d	h_{ef}	mm	180	216	288	360	450	576
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	62.20	89.57	173.72	271.43	424.12	694.87
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 20d	h_{ef}	mm	200	240	320	400	500	640
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	69.12	99.53	193.02	301.59	471.24	772.08
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10

[1] Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.

[2] Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.

[3] Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).

[4] Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.

[5] Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.

[6] The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.

[7] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at Min embedment depth

using reinforcing bars in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Nominal Anchor Diameter	d	mm	10	12	16	20	25	32
Characteristic Bond Strength	τ_{Rk}	N/mm²	11.00	11.00	12.00	12.00	12.00	12.00
Effective Embedment Depth	h_{ef}	mm	60	70	80	90	100	128
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	20.73	29.03	48.25	67.86	94.25	154.42
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	120	140	160	180	200	256
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	60	70	80	90	100	128
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	180	210	240	270	300	384
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	90	105	120	135	150	192

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
30	0.53					
35	0.57	0.53				
40	0.60	0.56	0.53			
45	0.64	0.59	0.56	0.53		
50	0.67	0.62	0.58	0.56	0.53	
60	0.75	0.68	0.64	0.6	0.57	
65	0.79	0.72	0.66	0.63	0.59	0.54
70	0.83	0.75	0.69	0.65	0.62	0.55
80	0.91	0.82	0.75	0.70	0.66	0.58
90	N/R	0.89	0.81	0.75	0.70	0.62
100		0.96	0.87	0.8	0.75	0.65
105		N/R	0.90	0.83	0.77	0.67
110			0.93	0.86	0.80	0.69
115			0.97	0.88	0.82	0.70
120			N/R	0.91	0.85	0.72
125				0.94	0.87	0.74
130				0.97	0.9	0.76
135				N/R	0.92	0.78
140					0.95	0.79
145					0.97	0.81
150					N/R	0.83
155						0.85
160						0.87
165						0.89
170						0.91
175						0.93
180						0.95
185						0.97
190						0.99
192						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
30	0.61					
35	0.62	0.59				
40	0.63	0.60	0.58			
45	0.65	0.61	0.59	0.58		
50	0.66	0.62	0.60	0.59	0.58	
55	0.67	0.63	0.61	0.60	0.59	
60	0.69	0.65	0.63	0.61	0.60	0.58
65	0.70	0.66	0.64	0.62	0.61	0.58
70	0.71	0.67	0.65	0.63	0.62	0.59
80	0.74	0.69	0.67	0.65	0.63	0.6
90	0.76	0.72	0.69	0.67	0.65	0.62
100	0.79	0.74	0.71	0.69	0.67	0.63
120	0.84	0.79	0.75	0.72	0.70	0.66
140	0.90	0.83	0.79	0.76	0.73	0.68
160	0.95	0.88	0.83	0.80	0.77	0.71
180	N/R	0.93	0.88	0.83	0.80	0.73
200		0.98	0.92	0.87	0.83	0.76
210		N/R	0.94	0.89	0.85	0.77
220			0.96	0.91	0.87	0.79
240			N/R	0.94	0.90	0.81
260				0.98	0.93	0.84
270				N/R	0.95	0.85
280					0.97	0.86
300					N/R	0.89
320						0.92
340						0.94
360						0.97
380						0.99
384						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at Std embedment depth

using reinforcing bars in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Nominal Anchor Diameter	d	mm	10	12	16	20	25	32
Characteristic Bond Strength	τ_{Rk}	N/mm²	11.00	11.00	12.00	12.00	12.00	12.00
Effective Embedment Depth	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	31.10	45.62	77.21	128.18	197.92	361.91
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	180	220	256	340	420	600
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	90	110	128	170	210	300
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	242	291	384	506	630	810
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	121	145	192	253	315	405

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
45	0.56					
50	0.58					
55	0.61	0.56				
60	0.63	0.58				
65	0.66	0.60	0.54			
70	0.69	0.63	0.55			
80	0.75	0.67	0.58			
85	0.77	0.69	0.60	0.53		
90	0.80	0.72	0.62	0.55		
100	0.87	0.77	0.65	0.57		
105	0.90	0.79	0.67	0.58	0.53	
121	N/R	0.87	0.72	0.62	0.56	
140		0.97	0.79	0.67	0.60	
145		N/R	0.81	0.69	0.61	
150			0.83	0.70	0.62	0.56
160			0.87	0.73	0.64	0.57
180			0.95	0.78	0.68	0.60
192			N/R	0.82	0.71	0.62
200				0.84	0.73	0.63
220				0.90	0.77	0.67
240				0.96	0.82	0.70
253				N/R	0.85	0.72
260					0.86	0.73
280					0.91	0.77
300					0.96	0.80
315					N/R	0.83
325						0.85
350						0.89
375						0.94
405						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
45	0.65					
50	0.66					
55	0.66	0.64				
60	0.67	0.64				
65	0.68	0.65	0.58			
70	0.69	0.66	0.59			
80	0.71	0.68	0.60			
85	0.72	0.68	0.61	0.58		
90	0.73	0.69	0.62	0.59		
100	0.75	0.71	0.63	0.60		
105	0.76	0.71	0.64	0.60	0.58	
150	0.84	0.78	0.70	0.65	0.62	0.59
200	0.93	0.86	0.76	0.70	0.66	0.62
242	N/R	0.93	0.82	0.74	0.69	0.65
250		0.94	0.83	0.75	0.70	0.65
291		N/R	0.88	0.79	0.73	0.68
300			0.89	0.80	0.74	0.69
350			0.96	0.85	0.78	0.72
384			N/R	0.88	0.80	0.74
400				0.90	0.82	0.75
450				0.94	0.86	0.78
500				0.99	0.90	0.81
506				N/R	0.90	0.81
600					0.98	0.87
630					N/R	0.89
650						0.90
700						0.93
750						0.96
800						0.99
810						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

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Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at 20d embedment depth

using reinforcing bars in dry / wet, uncracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Nominal Anchor Diameter	d	mm	10	12	16	20	25	32
Characteristic Bond Strength	τ_{Rk}	N/mm²	11.00	11.00	12.00	12.00	12.00	12.00
Effective Embedment Depth	h_{ef}	mm	200	240	320	400	500	640
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	69.12	99.53	193.02	301.59	471.24	772.08
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	400	480	640	800	1000	1280
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	200	240	320	400	500	640
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	242	291	405	506	632	810
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	121	145	202	253	316	405

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
100	0.87					
110	0.93					
120	0.99	0.87				
121	N/R	0.87				
130		0.92				
140		0.97				
145		N/R				
150						
160			0.84			
170			0.88			
180			0.91			
190			0.95			
200			0.99	0.84		
202			N/R	0.84		
220				0.9		
240				0.96		
250				0.99	0.84	
253				N/R	0.85	
260					0.86	
280					0.91	
300					0.96	
316					N/R	
320						0.84
340						0.88
360						0.91
380						0.95
400						0.99
405						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
100	0.78					
120	0.81	0.77				
140	0.84	0.80				
160	0.87	0.83	0.75			
180	0.90	0.85	0.77			
200	0.94	0.88	0.79	0.74		
242	N/R	0.94	0.83	0.77		
250		0.95	0.84	0.78	0.72	
291		N/R	0.88	0.82	0.75	
300			0.89	0.82	0.76	
320			0.91	0.84	0.77	0.71
350			0.94	0.87	0.80	0.72
400			0.99	0.91	0.83	0.75
405			N/R	0.91	0.84	0.76
450				0.95	0.87	0.78
500				0.99	0.90	0.81
506				N/R	0.91	0.82
550					0.94	0.84
600					0.98	0.87
632					N/R	0.89
650						0.90
700						0.93
750						0.96
800						0.99
810						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

Using TSIRCO-RES 341G with Reinforcing bars

Combined pullout and concrete cone failure in cracked concrete C20/25

Size				Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Characteristic bond resistance in cracked concrete									
Characteristic bond resistance dry/wet concrete		τ_{Rk}	[N/mm^2]	8.5	8.5	6.5	6.5	4.5	4.5
Partial safety factor		γ_{Mc}	[-]	1.8	2.1				
Factor for concrete	C30/37		ψ_c	1.04					
	C40/45			1.07					
	C50/60			1.09					

Splitting failure

Size			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Edge distance	[mm]		$1.0 * h_{ef} \leq 2.0 * h_{ef} * \left(2.5 - \frac{h}{h_{ef}}\right) \leq 2.4 * h_{ef}$					
Spacing	[mm]		$2 \bullet C_{cr,sp}$					
Partial safety factor	γ_{Msp}	[-]	1.8					

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at various embedment depths

using reinforcing bars in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Effective Embedment Depth = MIN	h_{ef}	mm	60	70	80	90	100	128
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	16.02	22.43	26.14	36.76	35.34	57.91
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 6d	h_{ef}	mm	60	72	96	120	150	192
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	16.02	23.07	31.37	49.01	53.01	86.86
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 8d	h_{ef}	mm	80	96	128	160	200	256
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	21.36	30.76	41.82	65.35	70.69	115.81
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 10d	h_{ef}	mm	100	120	160	200	250	320
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	26.70	38.45	52.28	81.68	88.36	144.76
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = STD	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	24.03	35.25	41.82	69.43	74.22	135.72
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 12d	h_{ef}	mm	120	144	192	240	300	384
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	32.04	46.14	62.73	98.02	106.03	173.72
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 14d	h_{ef}	mm	140	168	224	280	350	448
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	37.38	53.83	73.19	114.35	123.70	202.67
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 16d	h_{ef}	mm	160	192	256	320	400	512
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	42.73	61.52	83.64	130.69	141.37	231.62
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 18d	h_{ef}	mm	180	216	288	360	450	576
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	48.07	69.22	94.10	147.03	159.04	260.58
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Effective Embedment Depth = 20d	h_{ef}	mm	200	240	320	400	500	640
Characteristic Load (Combined concrete cone & pullout failure)	$N^0_{Rk,p}$	kN	53.41	76.91	104.55	163.36	176.71	289.53
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10

[1] Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.

[2] Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.

[3] Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).

[4] Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.

[5] Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.

[6] The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm^2 for C20/25 concrete.

[7] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at Min embedment depth

using reinforcing bars in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Nominal Anchor Diameter	d	mm	10	12	16	20	25	32
Characteristic Bond Strength	τ_{Rk}	N/mm²	8.50	8.50	6.50	6.50	4.50	4.50
Effective Embedment Depth	h_{ef}	mm	60	70	80	90	100	128
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	16.02	22.43	26.14	36.76	35.34	57.91
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	120	140	160	180	200	256
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	60	70	80	90	100	128
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	180	210	240	270	300	384
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	90	105	120	135	150	192

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
30	0.53					
35	0.57	0.53				
40	0.6	0.56	0.53			
45	0.64	0.59	0.56	0.53		
50	0.67	0.62	0.58	0.56	0.53	
60	0.75	0.68	0.64	0.6	0.57	
65	0.79	0.72	0.66	0.63	0.59	0.54
70	0.83	0.75	0.69	0.65	0.62	0.55
80	0.91	0.82	0.75	0.7	0.66	0.58
90	N/R	0.89	0.81	0.75	0.7	0.62
100		0.96	0.87	0.8	0.75	0.65
105		N/R	0.9	0.83	0.77	0.67
110			0.93	0.86	0.8	0.69
115			0.97	0.88	0.82	0.7
120			N/R	0.91	0.85	0.72
130				0.97	0.9	0.76
135				N/R	0.92	0.78
140					0.95	0.79
145					0.97	0.81
150					N/R	0.83
155						0.85
160						0.87
165						0.89
170						0.91
175						0.93
180						0.95
185						0.97
190						0.99
192						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
30	0.59					
35	0.61	0.58				
40	0.62	0.6	0.58			
45	0.63	0.61	0.59	0.58		
50	0.65	0.62	0.6	0.59	0.59	
60	0.67	0.64	0.63	0.61	0.6	
65	0.69	0.65	0.64	0.62	0.61	0.58
70	0.7	0.67	0.65	0.63	0.62	0.59
80	0.73	0.69	0.67	0.65	0.64	0.6
90	0.76	0.71	0.69	0.67	0.65	0.62
100	0.78	0.74	0.71	0.69	0.67	0.63
120	0.84	0.79	0.75	0.72	0.7	0.66
140	0.89	0.83	0.79	0.76	0.74	0.68
160	0.95	0.88	0.83	0.8	0.77	0.71
180	N/R	0.93	0.88	0.83	0.8	0.73
200		0.98	0.92	0.87	0.84	0.76
210		N/R	0.94	0.89	0.85	0.77
220			0.96	0.91	0.87	0.79
240			N/R	0.94	0.9	0.81
260				0.98	0.93	0.84
270				N/R	0.95	0.85
280					0.97	0.86
300					N/R	0.89
320						0.92
340						0.94
360						0.97
380						0.99
384						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at Std embedment depth

using reinforcing bars in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Nominal Anchor Diameter	d	mm	10	12	16	20	25	32
Characteristic Bond Strength	τ_{Rk}	N/mm²	8.50	8.50	6.50	6.50	4.50	4.50
Effective Embedment Depth	h_{ef}	mm	90	110	128	170	210	300
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	24.03	35.25	41.82	69.43	74.22	135.72
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	180	220	256	340	420	600
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	90	110	128	170	210	300
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	213	255	298	372	387	496
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	106	128	149	186	194	248

[1] *Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.*
[2] *Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.*
[3] *Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.*
[4] *Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).*
[5] *Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.*
[6] *Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.*
[7] *The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.*
[8] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
45	0.59					
50	0.62					
55	0.65	0.59				
60	0.68	0.62				
65	0.71	0.64	0.6			
70	0.74	0.67	0.62			
80	0.81	0.72	0.66			
85	0.84	0.75	0.68	0.61		
90	0.88	0.78	0.71	0.63		
100	0.95	0.83	0.75	0.66		
105	0.99	0.86	0.78	0.68	0.67	
106	N/R	0.87	0.78	0.68	0.67	
120		0.95	0.85	0.73	0.72	
128		N/R	0.89	0.76	0.75	
140			0.95	0.81	0.79	
149			N/R	0.85	0.82	
150				0.85	0.83	0.71
160				0.89	0.87	0.74
180				0.97	0.94	0.79
186				N/R	0.97	0.81
194					N/R	0.83
200						0.85
210						0.88
220						0.91
230						0.94
240						0.97
248						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.*

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
45	0.65					
50	0.66					
55	0.67	0.64				
60	0.68	0.65				
65	0.69	0.66	0.65			
70	0.70	0.66	0.66			
80	0.72	0.68	0.67			
85	0.73	0.69	0.68	0.64		
90	0.74	0.70	0.69	0.65		
100	0.76	0.72	0.70	0.66		
105	0.78	0.73	0.71	0.66	0.69	
125	0.82	0.77	0.74	0.69	0.71	
150	0.87	0.81	0.78	0.72	0.74	0.70
200	0.97	0.90	0.85	0.78	0.80	0.74
213	N/R	0.92	0.87	0.80	0.81	0.75
225		0.95	0.89	0.82	0.83	0.76
250		0.99	0.93	0.85	0.85	0.79
255		N/R	0.94	0.85	0.86	0.79
275			0.97	0.88	0.88	0.81
298			N/R	0.91	0.90	0.83
300				0.91	0.91	0.83
325				0.94	0.93	0.85
350				0.97	0.96	0.87
372				N/R	0.98	0.89
375					0.99	0.90
387					N/R	0.91
400						0.92
450						0.96
496						N/R

[1] *Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.*
[2] *Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.*
[3] *Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.*
[4] *Interpolation is allowed.*
[5] *Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.*
[6] *Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.*

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Tension load calculations for combined concrete cone & pullout failure at 20d embedment depth

using reinforcing bars in dry / wet, cracked, C20/25 concrete. Temperature range -40°C to +40°C.

Property	Symbol	Unit	Anchor Size					
			Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Nominal Anchor Diameter	d	mm	10	12	16	20	25	32
Characteristic Bond Strength	τ_{Rk}	N/mm²	8.50	8.50	6.50	6.50	4.50	4.50
Effective Embedment Depth	h_{ef}	mm	200	240	320	400	500	640
Characteristic Load (Combined Concrete Cone and Pullout Failure)	$N^0_{Rk,p}$	kN	53.41	76.91	104.55	163.36	176.71	289.53
Partial Safety Factor	γ_{Mc}	-	1.80	2.10	2.10	2.10	2.10	2.10
Characteristic Anchor Spacing (Splitting Failure)	$S_{cr,sp}$	mm	400	480	640	800	1000	1280
Characteristic Edge Distance (Splitting Failure)	$C_{cr,sp}$	mm	200	240	320	400	500	640
Characteristic Anchor Spacing (Combined Concrete Cone and Pullout Failure)	$S_{cr,Np}$	mm	213	255	298	372	387	496
Characteristic Edge Distance (Combined Concrete Cone and Pullout Failure)	$C_{cr,Np}$	mm	106	128	149	186	194	248

[1] Characteristic loads are valid for combined concrete cone and pullout failure as defined by TR029 only. All other failure modes, including steel failure, detailed in TR029 as well as including combined effects of tension and shear, must be considered in accordance with TR029.
[2] Characteristic edge distance for splitting failure assumes $h/h_{ef} = 2.0$.
[3] Characteristic loads are valid for single anchors without close edge, anchor spacing or eccentric loading considerations.
[4] Tabulated values are valid for temperture range -40°C to +40°C (Max LTT = +24°C; Max STT = +40°C).
[5] Tabulated values are only valid for the installation conditions stated. Other conditions, such as different temperature ranges, may affect the performance of the product.
[6] Long term temperatures are those that remain roughly constant over prolonged periods. Short term temperatures occur over brief intervals, eg: diurnal cycling.
[7] The compressive strength of the concrete ($f_{ck,cube}$) is assumed to be 25 N/mm² for C20/25 concrete.
[8] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.

Reduction factors for close edge: Combined concrete cone and pullout failure

Close Edge Distance, C (mm)	Anchor Size						
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
100	0.95					
106	N/R					
110						
120		0.95				
128		N/R				
130						
140						
149						
150						
160			N/R			
170						
180						
186						
190						
194						
200				N/R		
210						
220						
230						
240						
248						
250					N/R	
260						
270						
280						
290						
300						
310						
320						N/R

[1] Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.
[2] Tabulated values are based on a single anchor with a single close edge. Tabulated values must not be used if multiple close edges exist.
[3] Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.
[4] Interpolation is allowed.
[5] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.
[6] Close edge distances must exceed or be equal to the minimum close edge distance (C_{min}) as defined in the ETA.

Reduction factors for anchor spacing: Combined concrete cone and pullout failure

Anchor Spacing Distance, S (mm)	Anchor Size					
	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
100	0.79					
120	0.83	0.79				
140	0.87	0.82				
160	0.91	0.85	0.82			
180	0.94	0.88	0.85			
200	0.98	0.92	0.88	0.82		
213	N/R	0.94	0.89	0.83		
225		0.95	0.91	0.84		
250		0.99	0.94	0.87	0.87	
255		N/R	0.95	0.88	0.88	
275			0.97	0.9	0.89	
298			N/R	0.92	0.92	
300				0.92	0.92	
320				0.95	0.94	0.87
325				0.95	0.94	0.87
350				0.98	0.97	0.89
372				N/R	0.99	0.91
375					0.99	0.91
387					N/R	0.92
400						0.93
425						0.95
450						0.97
475						0.98
496						N/R

[1] Tabulated values are only applicable for instances where combined concrete cone and pullout failure is the controlling failure mode as described by TR029. All other failure modes must be considered and different reduction factors may apply.
[2] Tabulated values are based on a group of 2 anchors with the geometry defined by "S" and "$S_{cr,Np}$" but without close edge considerations.
[3] Anchors with geometry different to that defined in the above table must be considered separately and the tabulated values must not be used.
[4] Interpolation is allowed.
[5] Tabulated values assume that the geometry of the anchor(s) and concrete member is sufficient to avoid splitting failure.
[6] Anchor spacing distances must exceed or be equal to the minimum anchor spacing (S_{min}) as defined in the ETA.

Head office:
Strovolos Industrial Zone,
P.O. Box 23863, 1687 Nicosia, CYPRUS.
Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

TSIRCO-RES 341G

Product Data Sheet

Using TSIRCO-RES 341G with Post-installed Rebar Connections Installation parameters

Rebar		Drill Hole (mm)	Cleaning Brush* (mm)	Min. Anchorage Length (mm)	Min. Lap/Splice Length (mm)	Max. Embedment Depth (mm)
Diameter (mm)	$f_{y,k}$ (N/mm^2)					
8	500	12	S12/13HF	170	300	400
10	500	14	S14/15HF	212	300	500
12	500	16	S18HF	255	300	600
14	500	18	S22HF	298	315	700
16	500	20	S22HF	340	360	800
20	500	25	S27HF	425	450	1000
25	500	32	S35HF	532	563	1000
28	500	35	S38HF	595	630	1000
32	500	40	S43HF	681	720	1000

Design bond strength values

Design values of the ultimate bond resistance f_{bd} in N/mm^2 for rotary hammer drilling and compressed air drilling for good bond conditions.

Rebar Ø (mm)	Concrete Class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8	1.6	2.0	2.3	2.7	3.0	3.4	3.7	3.7	
10									
12									
14									
16								3.7	4.0
20								4.0	
25									
28								3.7	
32					2.7	3.0			

**Tabulated values for f_{bd} are valid for good bond conditions according to EN 1992-1-1. For all other bond conditions multiply the values for f_{bd} by 0.7*

Head office:
Strovolos Industrial Zone,
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Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com

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Product Data Sheet

Important Notes

Use in Porous Substrates

This bonded anchor is not intended for use as a cosmetic or decorative product. When anchoring into porous or reconstituted stone it is recommended that technical assistance is sought. Due to the nature of the product, migration of the monomer in the resin may cause staining in certain materials. If you are still uncertain, it is advisable to test the resin by applying it in a small, discrete area and testing before using the resin on the project.

Important Note

Whilst all reasonable care is taken in compiling technical data on the Company's products, all recommendations or suggestions regarding the use of such products are made without guarantee, since the conditions of use are beyond the control of the Company. It is the customer's responsibility to satisfy himself that each product is fit for the purpose for which he intends to use it, that the actual conditions of use are suitable and that, in the light of our continual research and development programme the information relating to each product has not been superseded.

Head office:
Strovolos Industrial Zone,
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Tel: +357 22 - 487029 , Fax: +357 22 - 487716
htpp://www.tsircon.com