m1tr and m1tr-C Throughbolt, stainless steel A4/316

Torque-controlled expansion anchor made of stainless steel for use in cracked and non-cracked concrete

Option 1 F120 C1 C2

1 SPECIFICATIONS OF INTENDED USE

Anchorages subject to:
-Static and quasi-static loading
-Seismic load, category C1 loads
-Resistance to fire (F120)

Base materials:
-Cracked and non-cracked concrete
-Reinforced or unreinforced normal weight concrete of strength classes C20/25 to C50/60 according to EN 206-1: 2000/A2:2005

Approvals:
-European Technical Approval Option 1 for cracked and non-cracked concrete
-Fire resistance test certification for F120
-Seismic performance category C1 and C2

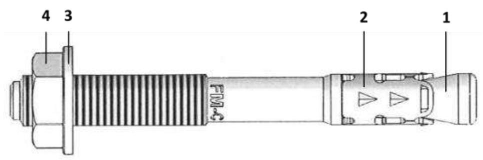
Reaction to fire:
-Anchorages satisfy requirements for Class A1

Resistance to fire:
-Resistance in cracked and non-cracked concrete under fire exposure (F120)
-For fire design see ETA-12/0375, Annex C 3 to C 8

Installation:
-Hole drilling by hammer drilling only
-Cleaning the holes
-The fastener may only be set once
-For further information see ETA-12/0375, Annex B1

1.2 DESIGNATION OF ANCHOR PARTS AND MATERIALS

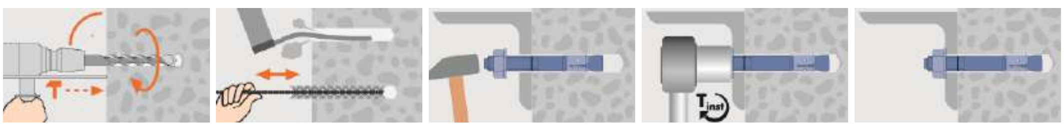
Part	Designation	Material
1	Bolt	Stainless steel X2CrNiMo 17-12-2 acc. To EN 10088-3 (wr. 1.4404)
2	Expansion sleeve	Stainless steel X2CrNiMo 17-12-2 acc. To EN 10088-3 (wr. 1.4404)
3	Washer	DIN 125/1 A4 (normal), DIN 9021 A4 (large). Stainless steel AISI 316 similar acc. To EN 10088-2
4	Hexagonal nut	DIN 934 A4-80 Stainless Steel AISI 316 similar acc. to ISO 3506-2



1.3 INSTALATION INSTRUCTIONS

- Drilling the hole
- Cleaning the hole
- Fixing plug and building material
- Tightening with the torque wrench and predetermined value of T_{inst}
- Tightened fixation

Graphic installation instruction for m1tr and m1tr-C



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2 PRODUCT INFORMATION

m1tr Throughbolt with washer DIN 125A, stainless steel A4/316

Article code	Dimensions [mm]	Length [mm] L	Length of screw in building material [mm] h_{nom}	Usable length [mm] t_{fix}	Effective anchorage depth [mm] h_{ef}
3700806	M8 x 68 / 4	68	54	4	48
3700807	M8 x 75 / 10	75	54	10	48
3700809	M8 x 90 / 25	90	54	25	48
3700811	M8 x 115 / 50	115	54	50	48
3700813	M8 x 135 / 70	135	54	70	48
3700816	M8 x 165 / 100	165	54	100	48
3701009	M10 x 90 / 10	90	67	10	60
3701010	M10 x 105 / 25	105	67	25	60
3701011	M10 x 115 / 35	115	67	35	60
3701013	M10 x 135 / 55	135	67	55	60
3701015	M10 x 155 / 75	155	67	75	60
3701018	M10 x 185 / 105	185	67	105	60
3701211	M12 x 110 / 10	110	81	10	72
3701212	M12 x 120 / 20	120	81	20	72
3701214	M12 x 145 / 45	145	81	45	72
3701217	M12 x 170 / 70	170	81	70	72
3701220	M12 x 200 / 100	200	81	100	72
3701613	M16 x 130 / 10	130	97	10	86
3701615	M16 x 150 / 30	150	97	30	86
3701618	M16 x 185 / 60	185	97	60	86
3701622	M16 x 220 / 100	220	97	100	86

m1tr-C Throughbolt with big washer DIN 9021, stainless steel A4/316

Article code	Dimensions [mm]	Length [mm] L	Length of screw in building material [mm] h_{nom}	Usable length [mm] t_{fix}	Effective anchorage depth [mm] h_{ef}
3710807	M8 x 75 / 10	75	54	10	48

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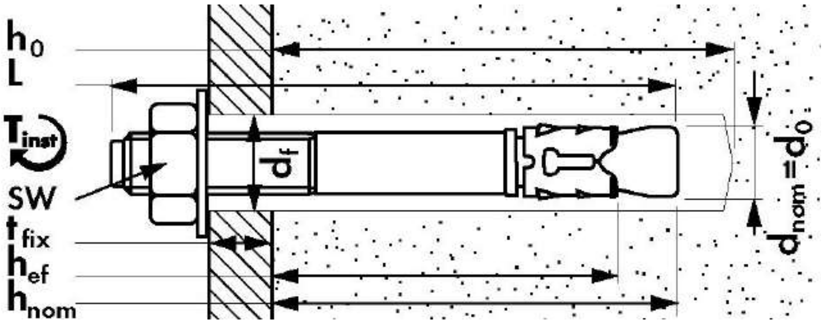
3 INSTALATION DATA m1tr and m1tr-C



FASTENER SIZE m1tr and m1tr-C			M8	M10	M12	M16
Anchor/Thread diameter	d	[mm]	8	10	12	16
Diameter of clearence hole in the fixture	df	[mm]	9	12	14	18
Spanner	SW	[mm]	13	17	19	24
INSTALLATION DATA						
Drill hole diameter in substrate	d_0	[mm]	8	10	12	16
Dept of drill hole in substrate	h_1	[mm]	70	80	100	115
Anchor embedment depth	h_{nom}	[mm]	54	67	81	97
Effective anchorage depth	h_{ef}	[mm]	48	60	72	86
Installation torque	T_{inst}	[Nm]	20	40	60	120
Minimum thickness of concrete memeber	h_{min}	[mm]	100	120	150	170
Minimum edge distane	c_{min}	[mm]	50	50	60	70
Corresponding spacing	s ≥	[mm]	50	110	120	130
Minimum spacing	s_{min}	[mm]	50	55	60	70
Corresponding edge distance	c ≥	[mm]	50	70	80	100

3.1 BASIC PERFORMANCE DATA

Basic performance data for m1tr and m1tr-C in cracked and non-cracked concrete C20/25 without influence of edge distance, spacing and splitting failure due to dimensions of concrete member

FASTENER SIZE m1tr and m1tr-C				M8	M10	M12	M16
Effective anchorage depth		h_{ef}	[mm]	48	60	72	86
CHARACTERISTIC RESISTANCE							
Tension load	non-cracked	$N_{Rk,ucr}$	[kN]	9.00	16.00	20.00	35.00
	cracked	$N_{Rk,cr}$	[kN]	5.00	9.00	12.00	25.00
Shear load	non-cracked	$V_{Rk,ucr}$	[kN]	11.90[1]	18.80[1]	27.40[1]	51.00[1]
	cracked	$V_{Rk,cr}$	[kN]	11.90[1]	18.80[1]	27.40[1]	51.00[1]
Bending moment , steel failure		$M^0_{Rk,s}$	[Nm]	24	49	85	216
DESIGN RESISTANCE							
Tension load	non-cracked	$N_{Rd,ucr}$	[kN]	6.00	10.67	13.33	23.33
	cracked	$N_{Rd,cr}$	[kN]	3.33	6.00	8.00	16.67
Shear load	non-cracked	$V_{Rd,ucr}$	[kN]	9.15[1]	14.46[1]	21.08[1]	39.23[1]
	cracked	$V_{Rd,cr}$	[kN]	7.98[3]	14.46[1]	21.08[1]	38.28[3]
Bending moment, steel failure		$M^0_{Rd,s}$	[Nm]	18.5	37.7	65.4	166.2
RECOMMENDED RESISTANCE							
Tension load (safety fac. 1,4)	non-cracked	$N_{rec,ucr}$	[kN]	4.29	7.62	9.52	16.66
	cracked	$N_{rec,cr}$	[kN]	2.38	4.29	5.71	11.91
Shear load (safety fac. 1,4)	non-cracked	$V_{rec,ucr}$	[kN]	6.54[1]	10.33[1]	15.06[1]	28.02[1]
	cracked	$V_{rec,cr}$	[kN]	5.70[3]	10.33[1]	15.06[1]	27.34[3]
Bending moment, steel failure (safety fac. 1,4)		$M^0_{rec,s}$	[Nm]	13.2	26.9	46.7	118.7

[1] Steel failure

[2] Concrete cone failure

[3] Pry-out failure

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4 INCREASING DESIGN RESISTANCE FOR CONCRETE STRENGTH CLASSES

Increasing resistance to tension and shear load in non-cracked concrete for different strength classes

NON-CRACKED CONCRETE, FASTENER SIZE m1tr and m1tr-C			M8	M10	M12	M16
INCREASING DESIGN RESISTANCE FOR CONCRETE STRENGTH CLASSES						
Tension load (non cracked concrete), N_{Rd}	C20/25	[kN]	6.00	10.67	13.33	23.33
	C25/30		6.57	11.69	14.61	25.56
	C30/37		7.30	12.98	16.22	28.39
	C35/45		8.05	14.32	17.89	31.32
	C40/50		8.49	15.09	18.86	33.01
	C45/55		8.90	15.83	19.79	34.63
	C50/60		9.30	16.53	20.67	36.17
Shear load (non cracked concrete), V_{Rd}	C20/25 to C50/60	[kN]	9.15	14.46	21.08	39.23

Increasing resistance to tension and shear load in cracked concrete for different strength classes

CRACKED CONCRETE, FASTENER SIZE m1tr and m1tr-C			M8	M10	M12	M16
INCREASING DESIGN RESISTANCE FOR CONCRETE STRENGTH CLASSES						
Tension load (cracked concrete), N_{Rd}	C20/25	[kN]	3.33	6.00	8.00	16.67
	C25/30		3.65	6.57	8.76	18.26
	C30/37		4.06	7.30	9.73	20.28
	C35/45		4.47	8.05	10.74	22.37
	C40/50		4.72	8.49	11.32	23.58
	C45/55		4.95	8.90	11.87	24.73
	C50/60		5.17	9.30	12.40	25.83
Shear load (cracked concrete), V_{Rd}	C20/25	[kN]	7.98	14.46	21.08	38.28
	C25/30		8.74	14.46	21.08	39.23
	C30/37 to C50/60		9.15	14.46	21.08	39.23

Increasing resistance for pull-out failure based on ETA-05/0070

For minimum spacing, minimum edge distance and thickness of concrete member the above described loads have to be reduced.

5 REDUCE DESIGN RESISTANCE TO TENSION LOADS FOR LIMITED EDGE AND SPACING DISTANCE

REQUIRED PROOFS FOR DESIGN TENSION RESISTANCE FOLLOWING ETAG 001 Annex C:

1. **For use in non-cracked concrete;** $N_{Rd,ucr} = \min(N_{Rd,s}; N_{Rd,p}; N_{Rd,c}; N_{Rd,sp})$
2. **For use in cracked concrete;** $N_{Rd,cr} = \min(N_{Rd,s}; N_{Rd,p}; N_{Rd,c})$

3. Reduction design resistance to tension loads is only valid for one limited edge distance or one limited spacing
4. It may be assumed that splitting failure will not occur, if the edge distance in all directions is $c \geq 1.2\ c_{cr,sp}$ and the member depth is $h \geq 2\ h_{ef}$ (see ETA ETA-12/0547 and ETAG 001 Annex C)
5. With anchoring in cracked concrete, the calculation of the resistance splitting failure may be omitted if a reinforcement is present which limits the crack and resistance for concrete cone failure and pull-out failure is calculated for cracked concrete according to conditions given in ETAG 001 Annex C, 5.2.2.6 and 7.3

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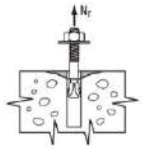
5.1 Steel failure $N_{Rd,s}$

Design resistance of one anchor in case of steel failure.

$N_{Rd,s} = N_{Rk,s} / \gamma_{Ms}$

FASTENER SIZE m1tr and m1tr-C			M8	M10	M12	M16
STEEL FAILURE						
Tension load γ_{Ms} = 1,5	$N_{Rd,s}$	[kN]	14.00	22.67	32.67	58.67

5.2 Pull-out failure $N_{Rd,p}$

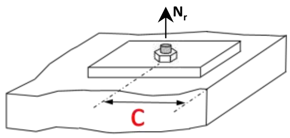


Design resistance in case of failure of one anchor by pull-out.

$N_{Rd,p} = N_{Rk,p} / \gamma_{Mp}$

FASTENER SIZE m1tr and m1tr-C				M8	M10	M12	M16
PULL-OUT FAILURE, CONCRETE C20/25							
Tension load γ_{Mp} = 1,5	non-cracked	$N_{Rd,ucr}$	[kN]	6.00	10.67	13.33	23.33
	cracked	$N_{Rd,cr}$	[kN]	3.33	6.00	8.00	16.67

5.3 Concrete cone failure and splitting failure in case of one limited edge



5.3.1 Design tension resistance of one anchor in case of concrete cone failure ($N_{Rd,c}$) with one limited edge

Reduction factor $\Psi_{edge} = (A_{c,N}/A^0_{c,N}) \cdot \Psi_{s,N}$ for concrete cone failure is only valid for one limited edge and without influence of spacing

$N_{Rd,c} = N^0_{Rd,c} \cdot \Psi_{edge}$; $N^0_{Rd,c} = N^0_{Rk,c} / \gamma_{Mc}$

FASTENER SIZE m1tr and m1tr-C				M8	M10	M12	M16
Minimum thickness of concrete memeber		hmin	[mm]	100	120	150	170
CONCRETE CONE FAILURE IN CASE OF LIMITED EDGE, CONCRETE C20/25							
Tension load γ_{Mc} = 1,5	non-cracked	$N^0_{Rd,c}$	[kN]	11.20	15.65	20.57	26.85
	cracked	$N^0_{Rd,c}$	[kN]	7.98	11.15	14.66	19.14
				x	x	x	x
				Ψedge	Ψedge	Ψedge	Ψedge
		Edge distance [mm]	50	0.77			
			55	0.82	0.71		
			60	0.87	0.75	0.67	
			65	0.92	0.79	0.71	
			70	0.98	0.83	0.74	0.67
			75	1.00	0.87	0.77	0.69
			85	1.00	0.96	0.84	0.74
			100	1.00	1.00	0.94	0.83
			110	1.00	1.00	1.00	0.89
			120	1.00	1.00	1.00	0.94
			130	1.00	1.00	1.00	1.00

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5.3.2 Design tension resistance of one anchor in case of splitting failure ($N_{Rd,sp}$) with one limited edge

Reduction factor Ψedge = ($A_{c,N}/A^0_{c,N}$) · $Ψ_{sp,N}$ for splitting failure is only valid for one limited edge and without influence of spacing

$N_{Rd,sp} = N^0_{Rd,sp} \cdot Ψedge$; $N^0_{Rd,sp} = N^0_{Rk,sp} / γ_{Msp}$

FASTENER SIZE m1tr and m1tr-C			M8	M10	M12	M16
Minimum thickness of concrete memeber	hmin	[mm]	100	120	150	170
SPLITTING FAILURE IN CASE OF LIMITED EDGE, CONCRETE C20/25						
Tension load $γ_{Msp}$ = 1,5 non-cracked	$N^0_{Rd,sp}$	[kN]	11.20	15.65	20.57	26.85
			x	x	x	x
			Ψedge	Ψedge	Ψedge	Ψedge
Edge distance [mm]		50	0.77			
		55	0.82	0.71		
		60	0.87	0.75	0.67	
		65	0.92	0.79	0.71	
		70	0.98	0.83	0.74	0.67
		75	1.00	0.87	0.77	0.69
		85	1.00	0.96	0.84	0.74
		100	1.00	1.00	0.94	0.83
		110	1.00	1.00	1.00	0.89
		120	1.00	1.00	1.00	0.94
		130	1.00	1.00	1.00	1.00

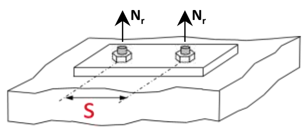
Factor Ψh,sp for splitting failure can be considered if h > h_{min}

$N_{Rd,sp} = N^0_{Rd,sp} \cdot Ψedge \cdot Ψ_{h,sp}$

$Ψ_{h,sp} = \left(\frac{h}{hmin}\right)^{2/3} \leq 1.5$

h = actual thickness of the member
hmin = minimum thickness of concrete member

5.4 Concrete cone failure and splitting failure in case of limited spacing



5.4.1 Design tension resistance of one anchor in case of concrete cone failure ($N_{Rd,c}$) with one limited spacing

Reduction factor Ψspacing = ($A_{c,N}/A^0_{c,N}$) for concrete cone failure is only valid for one limited spacing and without influence of edge

$N_{Rd,c} = N^0_{Rd,c} \cdot Ψspacing$; $N^0_{Rd,c} = N^0_{Rk,c} / γ_{Mc}$

FASTENER SIZE m1tr and m1tr-C				M8	M10	M12	M16
Minimum thickness of concrete memeber		hmin	[mm]	100	120	150	170
CONCRETE CONE FAILURE IN CASE OF LIMITED SPACING BETWEEN ANCHORS, CONCRETE C20/25							
Tension load $γ_{Mc}$ = 1,5	non-cracked	$N^0_{Rd,c}$	[kN]	11.20	15.65	20.57	26.85
	cracked	$N^0_{Rd,c}$	[kN]	7.98	11.15	14.66	19.14
				x	x	x	x
				Ψspacing	Ψspacing	Ψspacing	Ψspacing
Spacing between anchors [mm]			50	0.67			
			55	0.69	0.65		
			60	0.71	0.67	0.64	
			65	0.73	0.68	0.65	
			70	0.74	0.69	0.66	0.64
			75	0.76	0.71	0.67	0.65
			85	0.80	0.74	0.70	0.66
			100	0.85	0.78	0.73	0.69
			110	0.88	0.81	0.75	0.71
			120	0.92	0.83	0.78	0.73
			130	0.95	0.86	0.80	0.75
			140	0.99	0.89	0.82	0.77
			150	1.00	0.92	0.85	0.79
			170	1.00	0.97	0.89	0.83
			200	1.00	1.00	0.96	0.89
			250	1.00	1.00	1.00	0.98
			300	1.00	1.00	1.00	1.00

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5.4.2 Design tension resistance of one anchor in case of splitting failure ($N_{Rd,sp}$) with one limited spacing

Reduction factor Ψspacing = ($A_{c,N}/A^0_{c,N}$) for splitting failure is only valid for one limited spacing and without influence of edge

$N_{Rd,sp} = N^0_{Rd,sp} \cdot \Psi_{spacing}$; $N^0_{Rd,sp} = N^0_{Rk,sp} / \gamma_{Msp}$

FASTENER SIZE m1tr and m1tr-C			M8	M10	M12	M16
Minimum thickness of concrete memeber	hmin	[mm]	100	120	150	170
SPLITTING FAILURE IN CASE OF LIMITED SPACING BETWEEN ANCHORS, CONCRETE C20/25						
Tension load γ_{Msp} = 1,5 non-cracked	$N^0_{Rd,sp}$	[kN]	11.20	15.65	20.57	26.85
			x	x	x	x
			Ψspacing	Ψspacing	Ψspacing	Ψspacing
Spacing between anchors [mm]	50		1.00			
	55		1.00	0.65		
	60		1.00	0.67	1.00	
	65		1.00	0.68	1.00	
	70		1.00	0.69	1.00	0.64
	75		1.00	0.71	1.00	0.65
	85		1.00	0.74	1.00	0.66
	100		1.00	0.78	1.00	0.69
	110		1.00	0.81	1.00	0.71
	120		1.00	0.83	1.00	0.73
	130		1.00	0.86	1.00	0.75
	140		1.00	0.86	1.00	0.77
	150		1.00	0.89	1.00	0.79
	170		1.00	0.92	1.00	0.83
	200		1.00	0.97	1.00	0.89
	250		1.00	1.00	1.00	0.98
	300		1.00	1.00	1.00	1.00

Factor Ψh,sp for splitting failure can be considered if $h > h_{min}$

$N_{Rd,sp} = N^0_{Rd,sp} \cdot \Psi_{spacing} \cdot \Psi_{h,sp}$

$\Psi_{h,sp} = \left(\frac{h}{h_{min}}\right)^{2/3} \leq 1.5$

h = actual thickness of the member

hmin = minimum thickness of concrete member

6 IMPORTANT NOTICE

Values given above are valid under the assumptions of sufficient cleaning of the drill hole and anchoring in non-cracked or cracked concrete. For the design the complete assessment ETA-12/0375 from 11 August 2015 has to be considered. In recommended resistance the partial safety factor for material as regulated in the ETA as a partial safety factor for load action γ_L = 1.4 are considered. For combination of tensile loads, shear loads, bending moments as well as well as reduced edge distances or spacing's (anchor groups) see ETA or Mungo design software. The data must be checked by the user under the responsibility of an engineer experienced in anchorage and concrete work. This is to ensure there are no errors and all data is complete and accurate and complies with all rules and regulations for the actual conditions and application. Anchor design is performed according to the ETAG 001, Annex C in combination with assessment ETA-12/0375 from 11 August 2015.

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