the right fixing

SPECIFICATION :

DE DEFINITION,

IDENTIFICATION

AND APPLICATION

SPIT EPOBAR

Dimensioning rules for steel reinforcement fixings for concrete according to Eurocode 2 regulations

JUNE 2007 – VALIDITY MAY 2010

Accepted by **SOCOTEC**
under No. PX 1117

SOCOTEC

■ Concrete

The operating loads which can be applied to anchors generally depend on the mechanical properties of the base material. In the case of concrete, it is customary to refer to its compressive strength.

According to the NF EN 206-1 and EN 1992-1-1standard, the compressive strength of concrete is expressed in terms of a characteristic resistance defined as being the strength value below which a maximum of 5 % of the whole possible strength measurements of the specified concrete must be located.

The strength must be determined according to ISO 4012 on cubic specimens 15 x 15 x 15 cm (called $f_{ck,cube}$) or a cylindrical specimens 16 x 32 cm (called $f_{ck,cyl.}$) 28 days old, complying with ISO 1920 and manufactured and stored according to ISO 2736.

Concrete is classified according to its compressive strength which is based on the classification per strength measured on cylinders as indicated in the NF EN 206-1 and EN 1992-1-1standard. For information, the table below gives an equivalence between the characteristic values and average strength on cylindrical and cubic specimens in Mpa.

	Characteristic strength f_{ck}		Average strength		
Classes	Cylinder 16 x 32 cm	Cube 15 x 15 x 15 cm	Cylinder (f_{cm}) 16 x 32 cm	Cube 15 x 15 x 15 cm	Cube 20 x 20 x 20 cm
C 16/20	16	20	20	25	24
♦ C 20/25	20	25	25	31	29
C 25/30	25	30	30	37	36
♦ C 30/37	30	37	37	46	43
C 35/45	35	45	45	56	53
♦ C 40/50	40	50	50	62	59
C 45/55	45	55	55	69	65
♦ C 50/60	50	60	60	72	68

♦ *The most usual classes.*

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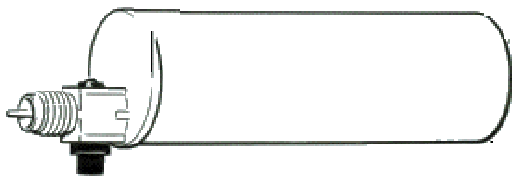
1 – THE EPOBAR RESIN

1.1 - Definition of the EPOBAR Resin

1.1.1 – SPIT EPOBAR cartridges : composition



① EPOBAR 410

② EPOBAR 910

The EPOBAR resin is composed of two components contained in a two-cylinder monoblock cartridge (these cylinders are concentric ① for EPOBAR 410 and juxtaposed ② for EPOBAR 910) :

. The large-diameter cylinder contains the VINYLESTER resin ;

. The small-diameter cylinder contains the hardener.

The table below summarizes the technical characteristic of the components:

	Density g/ml	Viscosity pas	Volume Cm^3		Net Weight g		Ignition Point
			EPOBAR 410	EPOBAR 910	EPOBAR 410	EPOBAR 910	
Vinylester resin	1.59	60	373	827	593	1315	53°C
Hardener	1.59	95	37	83	59	94	93°C
Mixture	-	-	410	910	652	1447	-

The EPOBAR resin's mechanical characteristics after polymerization :

	Polymerized EPOBAR resin
Compressive strength	80 Mpa
Young's modulus	5100 N/mm²
Shore hardness D	90

1.1.2 – Storage conditions

The cartridges must be stored at temperatures between +5°C and 35°C.

1.1.3 – Marking

The usage limit date is affixed to the cartridge in the following format : DD MM YY.

1.2 – Description of the Injection System

1.2.1 – Nozzles

The CM12L nozzle for the EPOBAR 410 cartridges :

The E910 nozzle for the EPOBAR 910 cartridges + 1 m extension :

Note : The CM12L and E910 nozzles are adapted to the EPOBAR resin in order to obtain a good mixture. The product does not accept other nozzles.

1.2.2 – Injection guns

injection tool 380-410 code 77151
for concentric cartridges vol. 410 ml

injection tool 910 code 063750
for coaxial cartridges vol. 910 ml

These guns consist of a frame and a mechanical system made of steel, a highly ergonomically designed 18 / 1 ratio handle for the 410 gun and 26 / 1 ratio handle for the 910 gun.

The guns benefit from a double guidance.

The blocking tab at the rear allows instantaneously eliminating the resin pressure.

1.2.3 – Cleaning brushes

- 10 / 16 / 25 / 30 mm dia. cleaning brush
- 320 mm extension
- 300 mm handle

2 – OPERATING PRINCIPLE

The EPOBAR resin used for the fixing of steel reinforcements in concrete is an injectable resin inserted in the drill hole (~50 % volume) using an injection tool and its nozzle. Thus, by passing through the nozzle, the 2 constituents of the cartridge (vinylester resin + hardener) are mixed to cause a chemical reaction which is going to allow the EPOBAR resin to progressively harden.

Once the resin is injected, the steel rebar is inserted in the drill hole down to the effective anchoring depth. The resin is thus going to be spread around the steel reinforcement and the fixture is then going to adhere to the concrete walls. (see table §7.2 for the installation and complete curing time).

3 – THE APPLICATION FIELD

This Specification applies to the use of the EPOBAR resin in both reinforced or non-reinforced concrete in a floor, wall or ceiling position.

This Specification is intended for the use of the EPOBAR resin in the fixing of steel reinforcements in concrete whose characteristic strength on a 28-day old sample is a minimum 20 Mpa**. The concrete can be dry or wet.**

The EPOBAR resin can be used in cracked or hollow concrete and in other solid building materials, but the values in this Specification cannot be used. Please consult us to define the specific tests to be performed accordingly.

4 – EPOBAR RESIN PERFORMANCES : TENSILE TESTS ON REBARS

4.1 – Tensile Tests on Rebars

Pull out tests in a dry and wet environment according to the NFP 18-831 standard allowed validating the use of the EPOBAR resin for the fixing of reinforcements.

On the other hand, creep tests on wet concrete were carried out according to the test methodology of the NFP18-836 standard, and satisfied the criteria of the NFP18-822 standard. (see § 5.3.1).

4.2 – Minimum Anchoring Depths Guaranteeing the failure of Steel rebar

The minimum anchoring depths were experimentally determined in order to obtain a minimum failure load according to the NFA 35016 standard. The minimum drill hole diameters were determined in order to obtain a free introduction of the steel rebars into the drilled hole.

The table below gives the results obtained for the failure of the steel rebar Fe E500 (mm) (confined tests).

Steel rebar ∅	8	10	12	14	16	20	25	32	40
Drill hole ∅	10 - 12	12 - 15	15 - 18	18 - 20	20 - 24	25 - 28	30 - 32	40	50
Anchoring depth (mm) for $f_{ck} \geq 20$ Mpa	60	80	100	110	130	160	190	250	250
Failure load (daN) for $f_{ck} \geq 20$ Mpa	3030	4850	6985	9000	12700	18500	31200	50000	65957
Conventional elasticity limit (daN)	2515	3925	5650	7700	10050	15700	24550	40200	62850

The anchoring depths specified above allow judging the resin's performances, but cannot be used for the design of the anchoring. The dimensioning rules defined in §6 have to be applied.

4.3 – Bonding strength

The **characteristic bonding strength** was determined from all the tests performed at a reduced depth, allowing to obtain a bond failure (~6 x Østeel-bar) in a concrete of the C20/25 class.

Its value is **17.85 N/mm²** for steel bar diameters varying from 8 to 40 mm.

4.4 – Behaviour in a wet concrete

The test results presented below highlight the fact that the EPOBAR resin is hardly sensitive to wet drilling conditions

Test conditions	Steel rebar Ø mm	Drill hole Ø mm	Anchoring depth mm	Failure load (daN) for $f_{ck} \geq 20$ Mpa	Conventional elasticity limit daN
Wet	12	15	120	7370	5650

The results obtained demonstrate that we obtain the failure rebar for the steel bar having a anchoring length equal to 10 x $Ø_{steel\text{-}bar}$ in a wet environment. These drilling conditions in a wet environment therefore remain acceptable in order to apply the dimensioning rules of the EUROCODE 2.

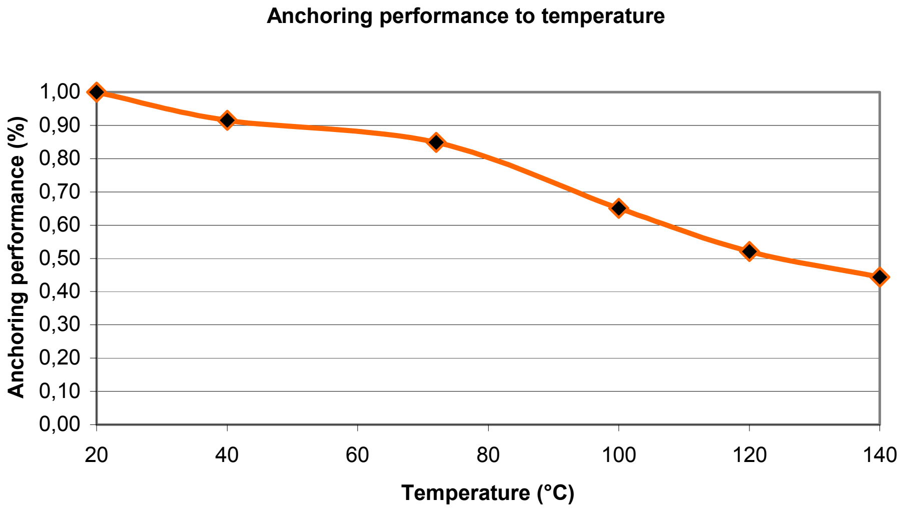
The EPOBAR resin is waterproof and adapted for a usage in a wet environment.

Note : In compliance with the procedure defined in the Guideline for European Technical Approval (ETAG), Part 5, untitled "Bonded anchors", the concrete was saturated with water by flooding the drill hole for 8 hours such that the water infiltrated the concrete. For the wet test, the water is swept out of the hole.

5 – CONDITIONS FOR USING SPIT EPOBAR RESIN

5.1 - EPOBAR Resin's Resistance to Temperature

Temperature tests were carried out from 20°C up to 140°C according to the requirements of the ETAG Guide, Part 5 untitled "Bonded anchors" (March 2001 Edition). For the various tested temperatures, pull out tests were conducted after the anchoring had been exposed in an oven at a constant temperature for 24 hours. The influence of the temperature is represented by the following graph :



5.2 – Behaviour in water

Tests in a wet environment such as defined in the ETA Guide, Part 5 untitled "Bonded anchors" (March 2001 Edition) were carried out (see §4.4). The results obtained revealed an excellent behaviour by the resin on wet supports. The dimensioning rules according to the EUROCODE 2 in §6 are applicable.

5.3 – Behaviour under a Long-Term Load

5.3.1 – Reference tests according to the NFP 18 836 standard

Creep tests in an humid base material were conducted in compliance with the NFP 18836 standard. The SPIT EPOBAR resin exhibited an excellent behaviour since small displacements with stability over time were observed and a residual load having attained the failure of the steel rebar. The results obtained were compliant with the criteria of the NFP 18822 standard (NF marking requirements).

5.3.2 – Resistance to long-term loading at + 50°C

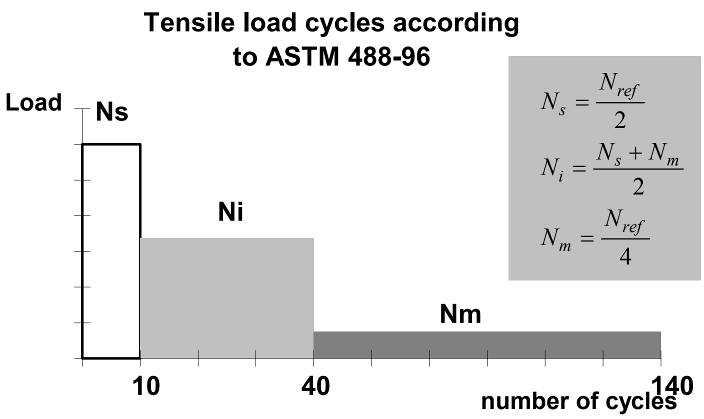
Creep tests were carried out in an oven at a temperature of 50°C for 2 months. The SPIT EPOBAR resin exhibited an excellent behaviour since small displacements between 0.7 and 0.95 mm with stabilization over time were observed and a residual load greater than the reference value was obtained. The test results obtained allow guaranteeing the dimensioning rules specified in §6.

5.4 – Behaviour to pulsating loads

Tests with pulsating loads were carried out for the EPOBAR sealing of M10 sizes. The sealing was subjected to 10^5 load cycles ; these load variations did not have any effect on the ″pin″.

5.5 – Seismic behaviour

The EPOBAR resin’s behaviour to earthquakes was checked based on the test standard ASTM 488-96. The test procedure consists of applying 140 load cycles at a frequency of 2 Hz in order to simulate seismic stress forces. The following tensile cycles were applied to the anchoring in an uncracked C20/25 concrete :



Tests were carried out on a 12 mm dia. steel bar.

The standard’s requirements were achieved :

- No anchoring failure during the load cycles ;
- Stabilized displacements ;
- Failure load equal to the reference value after application of the cycles

5.6 – Electric Conductibility

Electric conductibility tests were carried out in the LCIE laboratory in compliance with the IEC standards 60243-1 and 60093 :

- Volume resistivity at 23°C – 50% RH : ***2.8 x*** $\boldsymbol{10^{14}\ \Omega m}$
- Relative permittivity at 23°C – 50% RH – 50 Hz / 1000 Hz / 10^6 Hz ***: 4***
- Dielectric strength at 23°C – 50% RH – 50 Hz : ***10.1 kN/mm*** determined from a 3 mm thick sample.

5.7 - Resistance of SPIT EPOBAR resin to Chemical Agents

Chemical resistance was determined by exposing the resin samples to an attack by various substances. The samples resistance was determined by a visual inspection and classified into 3 states (resistant, sensitive, non resistant).

The various tested substances and the resistance of the SPIT EPOBAR mortar are given in **Appendix 1**.

5.8 - Resistance of the SPIT EPOBAR resin in specific atmospheres

Mortar endurance tests in different environments were carried out according to the ATE Guide, Part 5 untitled "Bonding anchors" (March 2001 Edition) in order to check the influence of these environments on the adherence force's resistance. The following environments were tested :

. Immersed in a high alkalinity solution (pH = 13.2) for 2000 hours ;

. Sulfurous atmosphere for 80 cycles alternating 8 hours in a sulfur dioxide atmosphere and 16 hours in a laboratory environment. The sulfur dioxide atmosphere corresponds to the introduction of 0.67% in SO_2 in an atmosphere at 40°C – 100 % RH ; therefore, sulphuric acid is created when in contact with the resin.

The results obtained for these endurance tests allowed guaranteeing the mortar's adherence resistance was not adversely affected by each of the atmospheres.

6 – DESIGN OF WORKS

6.1 – Mechanical Characteristics of rebars

The mechanical characteristics of the high adhesion rebars are defined in the NFA 35-016 and NFA 35-017 standards .

Nominal steel bar ∅		**8**	**10**	**12**	**14**	**16**	**20**	**25**	**32**	**40**
Sections (cm²)		0.503	0.785	1.13	1.54	2.01	3.14	4.91	8.04	12.57
Min. resistances to failure (daN)	Fe E400	2113	3297	4746	6468	8442	13188	20622	33768	52794
	Fe E500	2590	4043	5820	7931	10352	16171	25287	41406	64736
Ultimate limit load (daN)	**Fe E500**	**2185**	**3415**	**4917**	**6693**	**8742**	**13659**	**21343**	**34956**	**54636**

6.2 – Anchoring Depth calculation

Considering the hypothesis proved during the tests that the ultimate bonding strength of resin with versus concrete is at least equal to the one of high adhesion rebar in concrete, we can apply the formulas given in EUROCODE 2 – defined in the European Standard EN 1992-1-1 April 2004 (§8.4.3).

The anchorage depth Lb (mm) for the ultimate limit load for rebar N_{RD} (N) is given by following equation ::

$$L_b = \frac{\varnothing_t}{4} \cdot \left(\frac{f_{yd}}{f_{bd}} \right)$$

$\varnothing_t$: Drill hole diameter for the $\varnothing_{steel\text{-}bar}$ considered (mm)

f_{yd} : Elastic limit of rebar in N/mm²

$$f_{bd} = 2{,}25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd}$$

f_{bd} : Design values of the ultimate bond resistance (N/mm²)

$$f_{ctd} = \frac{f_{ctk5\%}}{\gamma_c}$$

f_{ctd} : Design tensile strength of concrete (N/mm²)

η_1 : depends on bond conditions
η_1 =1 (good bond conditions)
see § 8.4.2 (EN 1992-1-1)

$f_{ctk\,5\%}$: Characteristic tensile strength of concrete in N/mm².

η_2 : depends on rebar diameter
η_2 = 1 for Øbar ≤ 32 mm
η_2 = 0,92 for Øbar = 40 mm

γ_c Safety partial factor equal to 1,5

$$N_{RD} = As \cdot f_{yd}$$

N_{RD} Maximum ultimate limit load for rebar (N)

$$f_{yd} = \frac{f_{yk}}{1{,}15}$$

As Nominal cross section of rebar (mm²)

So for a design ultimate load F_{Rd} (≤ N_{Rd}) , The anchorage depth Ls is given by the following equation :

$$Ls = F_{Rd} \times \frac{\varnothing_t}{4} \cdot \left(\frac{f_{yd}}{f_{bd}} \right) \times \frac{1}{As \cdot f_{yd}} = F_{Rd} \times \frac{\varnothing_t}{4} \cdot \left(\frac{f_{yd}}{2{,}25 \cdot \eta_1 \cdot \eta_2 \cdot \frac{f_{ctk5\%}}{\gamma_c}} \right) \times \frac{1}{\left(\frac{\Pi \cdot \varnothing_t^{\,2}}{4} \right) \cdot f_{yd}} = \frac{1}{1{,}5 \cdot \eta_1 \cdot \eta_2 \cdot \Pi} \times \frac{F_{Rd}}{\varnothing_t \cdot f_{ctk5\%}}$$

After simplification , we obtain: $$Ls \sim \frac{F_{Rd}}{4{,}71 \cdot \eta_1 \cdot \eta_2 \cdot \varnothing_t \cdot f_{ctk5\%}}$$

With η_1 = 1 in good bond conditions.
In the opposite case, η_1 = 0,7 (see §8.4.2 - EN 1992-1-1 Standard, for more details).

η_2 = 1 for Øbar ≤ 32 mm
η_2 = 0,92 for Øbar = 40 mm

Concrete strength class	f_{ck} (Mpa)	**$f_{ctk5\%}$ (Mpa)**
C20/25	20	**1,5**
C25/30	25	**1,8**
C30/37	30	**2,0**
C35/45	35	**2,2**
C40/50	40	**2,5**
C45/55	45	**2,7**

(Concrete strength classes are described in page 1)

Limit of this formula :

- An installation reduced to 10 x $Ø_{steel\text{-}bar}$ (≥ 100 mm) is possible for a reduced ultimate load of the rebar in compliance with EUROCODE 2.

6.3 – Dimensioning tables of anchoring for Concrete According to the EUROCODE 2 Rules

These tables indicate the values obtained from the application of the formula determined in §6.2 taking into account the limit of use. (Calculation hypothesis η_1 = 1)

They give the anchoring depth and the number of HA Fe E500 rebar anchoring with EPOBAR 410 and 910 cartridges for the maximum possible ultimate limit load of the rebar or an ultimate limit load below the maximum ultimate load.

The ultimate loads in the tables below represent the calculation resistances to the Ultimate Limit State for the combinations of basic actions (non accidental).

6.3.1 - SPIT EPOBAR Resin - C20/25 Class Concrete (f_{ck} = 20 Mpa)

Steel bar Ø (mm)	Drill hole Ø d_0 (mm)	Anchorage Length (mm) Ls	Ultimate limit load (daN)	No. of sealings for a 410 ml cartridge *	No. of sealings for a 910 ml cartridge *
8	10	100	707	116	257
		160	1131	73	161
		250	1767	46	103
		309	**2185**	38	83
	12	100	848	52	116
		145	1230	36	80
		210	1781	25	55
		258	**2185**	20	45
10	12	100	848	95	211
		210	1781	45	100
		320	2714	30	66
		403	**3415**	24	52
	14	100	990	44	97
		190	1880	23	51
		280	2771	16	34
		345	**3415**	13	28
12	15	120	1272	43	95
		245	2598	21	47
		365	3870	14	31
		464	**4917**	11	25
	18	120	1527	19	43
		215	2736	11	24
		310	3944	7	17
		386	**4917**	6	13
14	18	140	1781	23	52
		280	3563	12	26
		420	5344	7.8	17
		526	**6693**	6.2	14
	20	140	1979	15	32
		260	3676	7,9	17
		380	5372	5,4	12
		473	**6693**	4,3	10
16	20	160	2262	18	40
		285	4029	10.2	23
		530	7493	5.5	12
		618	**8742**	4.7	10
	24	160	2714	8.2	18
		290	4920	4,5	10
		420	7125	3,1	7
		515	**8742**	2,5	6
20	25	200	3534	9.3	21
		405	7157	4.6	10
		610	10780	3.0	7
		773	**13659**	2.4	5
	28	200	3958	5.4	12
		380	7521	2,9	6
		560	11084	1,9	4
		690	**13659**	1,6	3
25	30	250	5301	6.1	13
		465	9861	3.3	7
		680	14420	2.2	5
		900	**3538**	1.7	4
	32	250	5655	4.2	9
		465	10518	2.3	5
		680	15381	1.5	3
		900	**20358**	1.2	3
32	40	320	9048	2.3	5
		510	14420	1.4	3
		700	19792	1.0	2
		900	**25447**	0.8	2
40	50	400	13006	1.2	3
		565	18371	0.8	2
		730	23736	0.6	1
		900	**29264**	0.5	1

* : with 20% loss

6.3.2 - SPIT EPOBAR Resin - Class Concrete C25/30 (f_{ck} = 25 Mpa)

Steel bar Ø (mm)	Drill hole Ø d_0 (mm)	Anchorage Length (mm) Ls	Ultimate limit load (daN)	No. of sealings for a 410 ml cartridge *	No. of sealings for a 910 ml cartridge *
8	10	100	848	116	257
		150	1272	*77*	*172*
		215	1824	*54*	*120*
		258	**2185**	*45*	*100*
	12	100	1018	52	116
		130	1323	*40*	*89*
		180	1832	*29*	*64*
		215	**2185**	*24*	*54*
10	12	100	1018	*95*	*211*
		190	1934	*50*	*111*
		280	2850	*34*	*75*
		336	**3415**	*28*	*63*
	14	100	1188	*44*	*97*
		170	2019	*26*	*57*
		245	2909	*18*	*39*
		288	**3415**	*15*	*34*
12	15	120	1527	*43*	*95*
		220	2799	*23*	*52*
		320	4072	*16*	*36*
		386	**4917**	*13*	*30*
	18	120	1832	*19*	*43*
		200	3054	*12*	*26*
		275	4199	*8*	*19*
		322	**4917**	*7*	*16*
14	18	140	2138	*23*	*52*
		250	3817	*13*	*29*
		365	5573	*8.9*	*20*
		438	**6693**	*7.4*	*17*
	20	140	2375	*15*	*32*
		240	4072	*8,5*	*19*
		330	5598	*6,2*	*14*
		395	**6693**	*5,2*	*12*
16	20	160	2714	*18*	*40*
		300	5089	*9.7*	*21*
		430	7295	*6.7*	*15*
		515	**8742**	*5.6*	*12*
	24	160	3257	*8.2*	*18*
		260	5293	*5,0*	*11*
		360	7329	*3,6*	*8*
		429	**8742**	*3,0*	*7*
20	25	200	4241	*9.3*	*21*
		370	7846	*5.0*	*11*
		535	11345	*3.5*	*8*
		644	**13659**	*2.9*	*6*
	28	200	4750	*5.4*	*12*
		340	8075	*3,2*	*7*
		485	11519	*2,2*	*5*
		575	**13659**	*1,9*	*4*
25	30	250	6362	*6.1*	*13*
		465	11833	*3.3*	*7*
		680	17304	*2.2*	*5*
		839	**21343**	*1.8*	*4*
	32	250	6786	*4.2*	*9*
		450	12215	*2.3*	*5*
		650	17643	*1.6*	*4*
		786	**21343**	*1.3*	*3*
32	40	320	10857	*2.3*	*5*
		510	17304	*1.4*	*3*
		700	23750	*1.0*	*2*
		900	**30536**	*0.8*	*2*
40	50	400	15607	*1.2*	*3*
		565	22045	*0.8*	*2*
		730	28484	*0.6*	*1*
		900	**35117**	*0.5*	*1*

* : with 20% loss

6.3.3 - SPIT EPOBAR Resin - Class Concrete C30/37 (f_{ck} = 30 Mpa)

Steel bar Ø (mm)	Drill hole Ø d_0 (mm)	Anchorage Length (mm) Ls	Ultimate limit load (daN)	No. of sealings for a 410 ml cartridge *	No. of sealings for a 910 ml cartridge *
8	10	100	942	116	257
		135	1272	*86*	*191*
		190	1791	*61*	*136*
		232	**2185**	*50*	*111*
	12	100	1131	52	116
		120	1357	*44*	*97*
		160	1810	*33*	*72*
		193	**2185**	*27*	*60*
10	12	100	1131	*95*	*211*
		170	1923	*56*	*124*
		250	2827	*38*	*84*
		302	**3415**	*31*	*70*
	14	100	1319	*44*	*97*
		160	2111	*27*	*60*
		215	2837	*20*	*45*
		259	**3415**	*17*	*37*
12	15	120	1696	*43*	*95*
		200	2827	*26*	*57*
		285	4029	*18*	*40*
		348	**4917**	*15*	*33*
	18	120	2036	*19*	*43*
		180	3054	*13*	*29*
		245	4156	*9*	*21*
		290	**4917**	*8*	*18*
14	18	140	2375	*23*	*52*
		230	3902	*14*	*31*
		325	5513	*10.0*	*22*
		395	**6693**	*8.3*	*18*
	20	140	2639	*15*	*32*
		220	4147	*9,3*	*21*
		300	5655	*6,8*	*15*
		355	**6693**	*5,8*	*13*
16	20	160	3016	*18*	*40*
		270	5089	*10.7*	*24*
		380	7163	*7.6*	*17*
		464	**8742**	*6.3*	*14*
	24	160	3619	*8.2*	*18*
		245	5542	*5,3*	*12*
		330	7464	*4,0*	*9*
		386	**8742**	*3,4*	*7*
20	25	200	4712	*9.3*	*21*
		340	8011	*5.5*	*12*
		480	11310	*3.9*	*9*
		580	**13659**	*3.2*	*7*
	28	200	5278	*5.4*	*12*
		315	8313	*3,5*	*8*
		430	11347	*2,5*	*6*
		518	**13659**	*2,1*	*5*
25	30	250	7069	*6.1*	*13*
		430	12158	*3.5*	*8*
		620	17530	*2.4*	*5*
		755	**21343**	*2.0*	*4*
	32	250	7540	*4.2*	*9*
		420	12667	*2.5*	*6*
		585	17643	*1.8*	*4*
		708	**21343**	*1.5*	*3*
32	40	320	12064	*2.3*	*5*
		510	19227	*1.4*	*3*
		700	26389	*1.0*	*2*
		900	**33929**	*0.8*	*2*
40	50	400	17342	*1.2*	*3*
		565	24495	*0.8*	*2*
		730	31648	*0.6*	*1*
		900	**39019**	*0.5*	*1*

* : with 20% loss

6.3.4 - SPIT EPOBAR Resin - Class Concrete C35/45 (f_{ck} = 35 Mpa)

Steel bar Ø (mm)	Drill hole Ø d_0 (mm)	Anchorage Length (mm) Ls	Ultimate limit load (daN)	No. of sealings for a 410 ml cartridge *	No. of sealings for a 910 ml cartridge *
8	10	100	1037	116	257
		125	1296	*93*	*206*
		170	1762	*68*	*151*
		211	**2185**	*55*	*122*
	12	100	1244	52	116
		115	1431	*45*	*101*
		150	1866	*35*	*77*
		176	**2185**	*30*	*66*
10	12	100	1244	*95*	*211*
		160	1991	*59*	*132*
		220	2737	*43*	*96*
		275	**3415**	*35*	*77*
	14	100	1451	*44*	*97*
		150	2177	*29*	*64*
		195	2830	*22*	*50*
		235	**3415**	*18*	*41*
12	15	120	1866	*43*	*95*
		190	2955	*27*	*60*
		260	4043	*20*	*44*
		316	**4917**	*16*	*36*
	18	120	2239	*19*	*43*
		170	3172	*14*	*30*
		225	4199	*10*	*23*
		263	**4917**	*9*	*20*
14	18	140	2613	*23*	*52*
		215	4012	*15*	*34*
		300	5598	*10.9*	*24*
		359	**6693**	*9.1*	*20*
	20	140	2903	*15*	*32*
		205	4251	*10,0*	*22*
		270	5598	*7,6*	*17*
		323	**6693**	*6,3*	*14*
16	20	160	3318	*18*	*40*
		250	5184	*11.6*	*26*
		345	7153	*8.4*	*19*
		422	**8742**	*6.9*	*15*
	24	160	3981	*8.2*	*18*
		230	5723	*5,7*	*13*
		300	7464	*4,4*	*10*
		351	**8742**	*3,7*	*8*
20	25	200	5184	*9.3*	*21*
		315	8164	*5.9*	*13*
		430	11145	*4.3*	*10*
		527	**13659**	*3.5*	*8*
	28	200	5806	*5.4*	*12*
		295	8563	*3,7*	*8*
		400	11611	*2,7*	*6*
		471	**13659**	*2,3*	*5*
25	30	250	7775	*6.1*	*13*
		405	12596	*3.7*	*8*
		560	17417	*2.7*	*6*
		686	**21343**	*2.2*	*5*
	32	250	8294	*4.2*	*9*
		390	12938	*2.7*	*6*
		530	17583	*2.0*	*4*
		643	**21343**	*1.6*	*4*
32	40	320	13270	*2.3*	*5*
		505	20942	*1.4*	*3*
		690	28614	*1.1*	*2*
		843	**34956**	*0.9*	*2*
40	50	400	19076	*1.2*	*3*
		565	26944	*0.8*	*2*
		730	34813	*0.6*	*1*
		900	**42920**	*0.5*	*1*

* : with 20% loss

6.3.5 - SPIT EPOBAR Resin - Class Concrete C40/50 (f_{ck} = 40 Mpa)

Steel bar Ø (mm)	Drill hole Ø d_0 (mm)	Anchorage Length (mm) Ls	Ultimate limit load (daN)	No. of sealings for a 410 ml cartridge *	No. of sealings for a 910 ml cartridge *
8	10	100	1178	116	257
		120	1414	*97*	*215*
		160	1885	*73*	*161*
		185	**2185**	*63*	*139*
	12	100	1414	52	116
		110	1555	*47*	*105*
		135	1909	*39*	*86*
		155	**2185**	*34*	*75*
10	12	100	1414	*95*	*211*
		150	2121	*63*	*140*
		205	2898	*46*	*103*
		242	**3415**	*39*	*87*
	14	100	1649	*44*	*97*
		140	2309	*31*	*69*
		180	2969	*24*	*54*
		207	**3415**	*21*	*47*
12	15	120	2121	*43*	*95*
		180	3181	*29*	*64*
		240	4241	*21*	*48*
		278	**4917**	*19*	*41*
	18	120	2545	*19*	*43*
		160	3393	*15*	*32*
		200	4241	*12*	*26*
		232	**4917**	*10*	*22*
14	18	140	2969	*23*	*52*
		205	4347	*16*	*35*
		270	5726	*12.1*	*27*
		316	**6693**	*10.3*	*23*
	20	140	3299	*15*	*32*
		195	4595	*10,5*	*23*
		250	5890	*8,2*	*18*
		284	**6693**	*7,2*	*16*
16	20	160	3770	*18*	*40*
		240	5655	*12.1*	*27*
		315	7422	*9.2*	*20*
		371	**8742**	*7.8*	*17*
	24	160	4524	*8.2*	*18*
		215	6079	*6,1*	*13*
		270	7634	*4,8*	*11*
		309	**8742**	*4,2*	*9*
20	25	200	5890	*9.3*	*21*
		300	8836	*6.2*	*14*
		395	11634	*4.7*	*10*
		464	**13659**	*4.0*	*9*
	28	200	6597	*5.4*	*12*
		280	9236	*3,9*	*9*
		360	11875	*3,0*	*7*
		414	**13659**	*2,6*	*6*
25	30	250	8836	*6.1*	*13*
		380	13430	*4.0*	*9*
		510	18025	*3.0*	*7*
		604	**21343**	*2.5*	*6*
	32	250	9425	*4.2*	*9*
		365	13760	*2.9*	*6*
		485	18284	*2.2*	*5*
		566	**21343**	*1.8*	*4*
32	40	320	15080	*2.3*	*5*
		475	22384	*1.5*	*3*
		630	29688	*1.2*	*3*
		742	**34956**	*1.0*	*2*
40	50	400	21677	*1.2*	*3*
		565	30619	*0.8*	*2*
		730	39561	*0.6*	*1*
		900	**48773**	*0.5*	*1*

* : with 20% loss

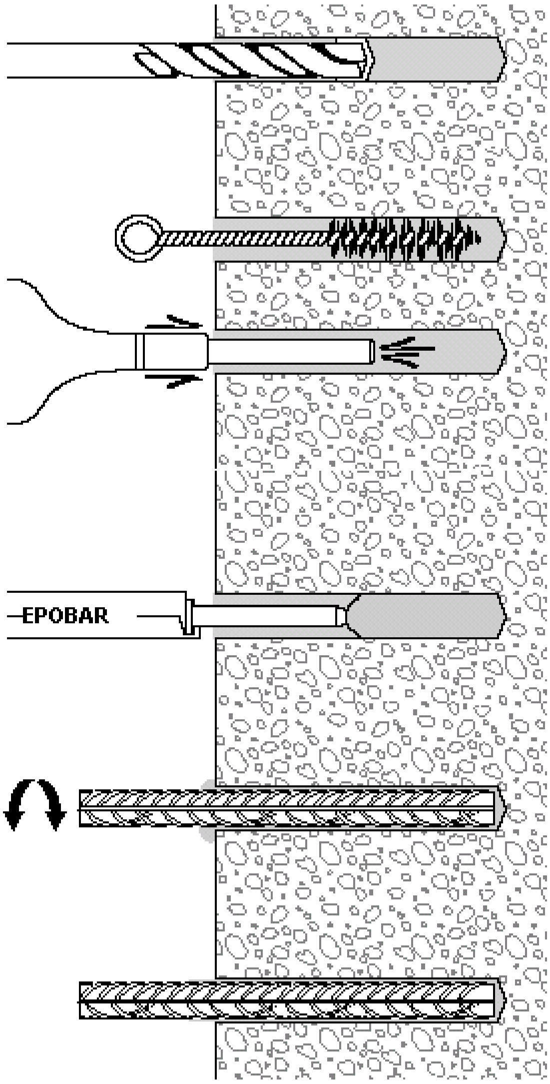
6.3.6 - SPIT EPOBAR Resin - Class Concrete C45/55 (f_{ck} = 45 Mpa)

Steel bar Ø (mm)	Drill hole Ø d_0 (mm)	Anchorage Length (mm) Ls	Ultimate limit load (daN)	No. of sealings for a 410 ml cartridge *	No. of sealings for a 910 ml cartridge *
8	10	100	1272	116	257
		110	1400	*105*	*234*
		145	1845	*80*	*178*
		172	**2185**	*68*	*150*
	12	100	1527	52	116
		100	1527	*52*	*116*
		125	1909	*42*	*93*
		143	**2185**	*36*	*81*
10	12	100	1527	*95*	*211*
		145	2214	*65*	*145*
		190	2901	*50*	*111*
		224	**3415**	*42*	*94*
	14	100	1781	*44*	*97*
		130	2316	*33*	*74*
		165	2939	*26*	*59*
		192	**3415**	*23*	*50*
12	15	120	2290	*43*	*95*
		170	3244	*30*	*67*
		220	4199	*23*	*52*
		258	**4917**	*20*	*44*
	18	120	2748	*19*	*43*
		150	3435	*15*	*34*
		190	4351	*12*	*27*
		215	**4917**	*11*	*24*
14	18	140	3206	*23*	*52*
		195	4466	*17*	*37*
		250	5726	*13.1*	*29*
		292	**6693**	*11.2*	*25*
	20	140	3563	*15*	*32*
		185	4708	*11,1*	*25*
		230	5853	*8,9*	*20*
		263	**6693**	*7,8*	*17*
16	20	160	4072	*18*	*40*
		225	5726	*12.9*	*29*
		290	7380	*10.0*	*22*
		344	**8742**	*8.4*	*19*
	24	160	4886	*8.2*	*18*
		205	6260	*6,4*	*14*
		250	7634	*5,2*	*12*
		286	**8742**	*4,6*	*10*
20	25	200	6362	*9.3*	*21*
		280	8906	*6.6*	*15*
		365	11610	*5.1*	*11*
		429	**13659**	*4.3*	*10*
	28	200	7125	*5.4*	*12*
		265	9441	*4,1*	*9*
		330	11756	*3,3*	*7*
		383	**13659**	*2,8*	*6*
25	30	250	9543	*6.1*	*13*
		360	13741	*4.2*	*9*
		470	17940	*3.2*	*7*
		559	**21343**	*2.7*	*6*
	32	250	10179	*4.2*	*9*
		350	14250	*3.0*	*7*
		450	18322	*2.3*	*5*
		524	**21343**	*2.0*	*4*
32	40	320	16286	*2.3*	*5*
		450	22902	*1.6*	*4*
		585	29773	*1.2*	*3*
		687	**34956**	*1.1*	*2*
40	50	400	23411	*1.2*	*3*
		565	33068	*0.8*	*2*
		730	42725	*0.6*	*1*
		900	**52675**	*0.5*	*1*

* : with 20% loss

7 – CONDITIONS OF USE

7.1 – Installation



Drill a hole according to the diameter selected in the dimensioning tables of anchoring.
Remark : A hole can also be drilled with a diamond bit.

Clean the drilled hole with a metal cleaning brush.

Blow the dust out of the drilled hole.
The drilled hole may also be cleaned with pressurized water.

Inject from the bottom of the hole, progressively moving back until 50 % or more.

For an installation in a ceiling, we recommend using a washer at the nozzle end or an extension to guarantee a good filling in the drilled hole bottom.

Insert the rebar by hand in a twisting motion until the end of the hole is reached. The rod must be clean and free from oil and grease.

Check that the hole is well filled (no air bubbles present). An excess amount of the mixture must appear at the end of the anchoring.

Wait until resin to harden before applying the load (see table §7.2)

7.2 – Curing time before loading

The curing rate is dependent on the ambient temperature :

Ambient temperature (°C)	Maximum installing time (min)	Wait time before loading (min)
40	2	50 min.
30	4.5	65 min.
20	6.5	110 min.
10	10	3 h 10 min.
5	17	4 h 10 min
0	26	5 h 15 min.
- 5	35	6 h 20 min.

8 – PRODUCTION AND QUALITY ASSURANCE

The EPOBAR resin is manufactured according to a control plan targeted at ensuring a regularity in quality.

This control plan concerns the materials used, the cartridge filling and the products terminated. In addition, tests are systematically carried out in our laboratories.

It is registered, as well as the production drawings, at SOCOTEC, which can check at any moment that the plan is being applied. Each cartridge has an identification marking to allow a traceability back to the production batch.

Furthermore, we are responsible for informing SOCOTEC of any change involving the EPOBAR resin system.

An external control is conferred to SOCOTEC.

9 - VALIDITY

This approval granted by SOCOTEC is valid from the date of issue of this document until May 31, 2010.

APPENDIX 1 :

Chemical Substances	Concentration %	Resistance
Ethyl acetate	100	(-)
Acetone	10	(+)
Acetone	100	(-)
Acetic acid	50-75	(o)
Acetic acid	0-50	(+)
Hydrochloric acid	37	(-)
Hydrochloric acid	25	(o)
Hydrochloric acid	15	(+)
Hydrochloric acid and organic compounds		(-)
Citric acid	0-100	(+)
Formic acid	50	(-)
Formic acid	10	(+)
Lactic acid	0-100	(+)
Nitric acid	2-15	(o)
Nitric acid	50	(-)
Phosphoric acid	80	(+)
Concentrated phosphoric acid	100	(+)
Phosphoric acid, vapor and condensed		(+)
Sulfuric acid	71-75	(o)
Sulfuric acid	0-70	(+)
Sulfuric acid	Fumes	(+)
Sulfuric acid	76-93	(-)
Sulfuric acid / Phosphoric acid	10:20	(+)
Benzyl alcohol	0-100	(-)
Ethyl alcohol (Ethanol)	50	(-)
Ethyl alcohol (Ethanol)	10	(o)
Ammoniac, dry gas	0-100	(-)
Ammoniac, liquified	0-100	(-)

Chemical Substances	Concentration %	Resistance
Aniline	0-100	(-)
Benzene	100	(-)
Sodium carbonate	10	(+)
Diesel fuel	0-100	(+)
Sodium chloride	0-100	(+)
Bromine water	5	(+)
Chlorine water	0-100	(+)
Sea water	0-100	(+)
Deionized water	0-100	(+)
Demineralized water		(+)
Leaded or no-lead gasoline	100	(-)
Turpentine (oil)		(o)
Ethanolamine	100	(-)
Ethylene glycol	0-100	(+)
Fuel	100	(+)
Heptane	100	(+)
Hexane	100	(o)
Heavy motor oil	100	(+)
Ammonium hydroxide or Ammoniac	25	(-)
Ammonium hydroxide or Ammoniac	20	(o)
Ammonium hydroxide or Ammoniac	5	(+)
Sodium hydroxide (or Caustic soda)	25	(o)
Methyl isobutyl ketone	100	(-)
Ozone ()	Concent. < 4 ppm in water	(-)
Phenol	5	(-)
Carbon tetrachloride	100	(-)
Trichloroethylene		(-)
Xylene	0-100	(-)

- ***Resistant*** (+) : The samples in contact with the substance do not exhibit any visible damages such as cracks, attacked surfaces, exploded corners or major swellings.

- ***Non resistant*** (-) : Usage not recommended. The samples in contact with the substance were damaged.

- ***Sensible*** (o) : Usage with precautions with respect to exposure, usage field, applications to be redone. The samples in contact with the substance exhibit a slight attack on the material.