STEEL BLUE® colour Blue & Yellow

Epoxy Chocking Compound Resin

DESCRIPTION

C-Systems**STEEL Blue**It was developed and formulated for leveling, incorporation, alignment, etc. in the marine, industrial and technical fields.
STEEL Blue It is a two-component, solvent-free epoxy system, filled with mineral aggregates, 100% dry residue.
STEEL Blue It withstands heavy compressive loads, thermal shocks, impacts, vibrations, tractions, even in the presence of water and oils.
STEEL Blue It forms the thickness, wedge, alignment support, without the need for classic metal notching which requires expert workmanship and a long execution period.

STEEL Blue It offers, at the same time, a perfect and permanent support interface. **STEEL Blue**It has virtually no shrinkage. The test - ASTM D 2566 test - on a length of 881.4 mm with a thickness of 30 mm after aging for 7 days at 25 °C, obtained a measurement of 881.06 mm: equal to 0.04%. The length and height measurements were taken using laser measurement.
STEEL Blue It is a partner of many shipyards and industrial sites, recommended by operators and technical installers in various fields of application.
STEEL Blue It has great capillarity and is able to precisely and quickly "kiss" the smallest details and fill the smallest crevices.

USE AND BENEFITS

Choice, reliability and convenience**STEEL Blue**are due to:

- TECHNICAL PERFORMANCE
- EASY PREPARATION
- EASY TO SET UP
- EASY AVAILABILITY
- EXPRESS SHIPPING SERVICE
- TECHNICAL ASSISTANCE ALSO BY TELEPHONE
-

STEEL Blue It was developed for filling, filling, levelling, aligning, equalising by casting the main machines, support supports etc.
STEEL Blue It is used for engine bases even with differentiated and offset supports for generator sets, gearboxes, inverters, propeller stands, propulsion unit supports for surface propellers, sail drive alignment, engine bases and bottoms, through-hull shaft stern tubes, winches, interface for chain plate attachments, interface for bulbs and fins, interface for anchor shields, etc.

Ambient temperature of use equal to or greater than 8°C up to 35°C.
Take care to keep the packages of**STEEL Blue**(parts A and B) in an environment with temperatures not lower than 10°C. Relative humidity up to 90%.

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For application, if necessary, warm the**STEEL Blue**place it in a heated environment or use radiators, oil radiators that heat it from below or other sources that heat it evenly.

After installation, maintain the temperature above the minimum required values.

Minimum gelling time :

Gelation time at 25°C 2.5 - 3.5 hours with a thickness of approximately 50 mm

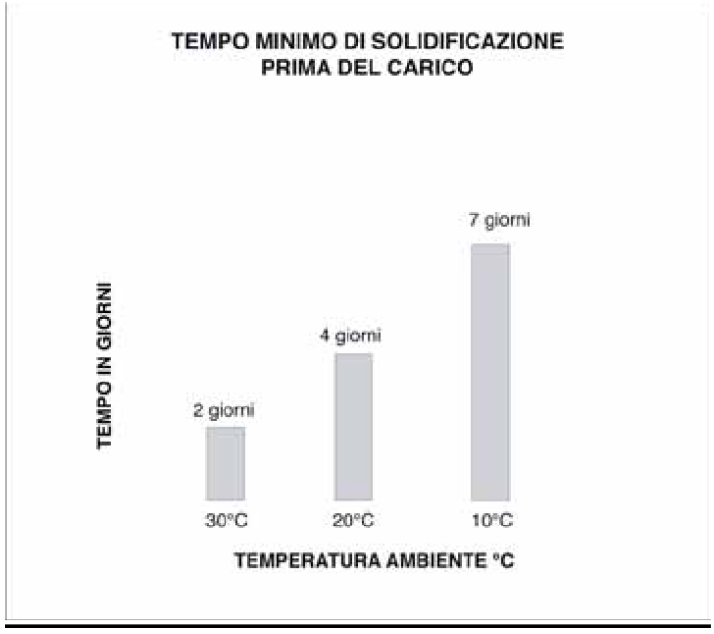
Gelation time at 10°C 7.0 - 8.0 hours with a thickness of approximately 50 mm

Maximum operating temperature value (CTS test report n°73313)

The resin**STEEL Blue**It does not propagate flame in the presence of possible ignition and can be used appropriately up to a maximum operating temperature of 90°C.

Minimum solidification time before loading / tightening bolts with torque wrench:

- 48 hours/ 2 days at 30°C,
- 4 days at 20°C,
- 7 days at 10°C



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TECHNICAL DATA

PACKAGE TYPE AND VOLUME PER UNIT Resin

	component A in a can from	8,535 kg
Hardener	component B in a bottle from	0.450 kg

Total weight (A + B) 8,985 kg

Total volume per package (A + B) (4,799 liters)

Component B is slightly overfilled at 5%, because the amount remaining in the container was calculated. If you carefully pour it all in, the excess promotes quicker cross-linking in cold weather (below 15°C); the additional hardener still complies with the mixing tolerances.
The different contrasting colors, especially of the yellow base A with the red component B, allow you to easily check that the perfect mix is achieved.

TECHNICAL CHARACTERISTICS OF THE SYSTEM

RESIN

Resin color		blue - yellow
Density at 25°C	ASTM D1475	g/ml 1.97 : 2.01
Viscosity at 25°C		mPas 80,000:130,000

HARDENER

Hardening color		yellow-orange - red
Density at 25°C	ASTM D1475	g/ml 0.86:0.90
Viscosity at 25°C		mPas 5:10

PROCESSING DATA

Weight ratio per 100 g resin Volume	g	100:5
ratio per 100 ml resin Pot life at 25°C (50	ml	100:12
mm; 200 ml)	min	25:35

APPLICATION INSTRUCTIONS

Homogenize component A with the drill for at least 2 minutes using the MIXER supplied with the **STEEL Blue**(maximum revolutions per minute 150)
Shake component B well and pour it into component A

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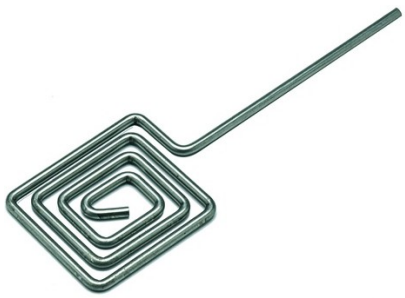
To perfectly homogenize component B with component A, mix the compound for approximately 5 minutes using the drill equipped with a MIXER, at a speed of 80 to a maximum of 150 rpm depending on the working temperature.

THE MIXER in harmonic steel, which comes with the first package of**STEEL Blue**It is specially designed in shape and size and is designed to be mounted on a drill with a variator to control its speed. For larger orders, one mixer is considered for every 10 packs.



STEEL Blue It mixes easily, even in winter, thanks to the perfect harmonization of the formulation's charges. The addition of the catalyst increases the fluidity of the mixture; the operator must adhere to the correct mixing ratio when preparing the product. The special shape of the mixer allows it to reach the bottom of the container and the edges perfectly without scratching or jamming the rotation.

The container of component A is generously sized in a ratio of more than 2 times, also taking into account component B, so that when mixing, by raising and lowering the mixer the material does not flow out due to the centrifugal force.

STEEL Blue It can be poured directly from its container or, if necessary due to lack of space, into a funnel and/or connected to the intervention area.
It's essential that the areas to be filled, no matter how complex, allow for air to escape, eliminating any unfilled areas. To facilitate drying, during the winter months, if necessary, use an infrared lamp with a temperature dimmer.

TYPE OF BARRIER REQUIRED FOR HORIZONTAL CASTING (FLAT) AND IN THE CASE OF A SYSTEM WITH A ROUND BASE

It is important that the party interested in the implementation of the**STEEL Blue**It must comply not only with the correct support but also with the possibility that the product can spread evenly and not create areas where it can trap air which would reduce the final mechanical characteristics of the casting.

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Also remove any traces of rust, oil, casting residues such as mud, ash, sand, electric or gas welding spots, and paint flakes. If necessary, sand and apply a coat of epoxy primer to protect the part from rust.
If future disassembly is foreseen, it is advisable to treat one part with a release agent or with ordinary melted wax applied with a brush.
The barriers can be constructed using wooden or thin sheet metal profiles held in place with hot glue dots and then trimmed with rubber sealant for a perfect seal or with oil-based filler.

The use of barriers mounted with plasticine or barriers held in place by sealing them with polyurethane rubber cartridges, or the use of expanded rubber profiles or strips with adhesive edges, are suitable for completely or partially demarcating and enclosing the intervention area. Particular attention must be paid to sealing the parts in areas that will come into direct contact with seawater, e.g., the propeller bracket section, the anchor pocket plate.
Having to make an alignment of 80 mm, the edges will be at least 100 - 120 mm high so that the casting of**STEEL Blue**can spread and level out in the following moments, even if applied quickly and generously, without causing spills.
It is advisable to pour the**STEEL Blue**taking into account the size of the casting after having calculated the volume where it is placed with an excess of at least 5 - 10%.

THE USE OF RELEASE AGENT

The barriers must be treated, for detachment, with grease, release wax or ordinary melted candle wax applied with a brush or other specific release agents supplied in spray cans.

In the case of propeller supports, flange supports, etc. where removal is foreseen, it is essential to apply the release agent to one side before casting.

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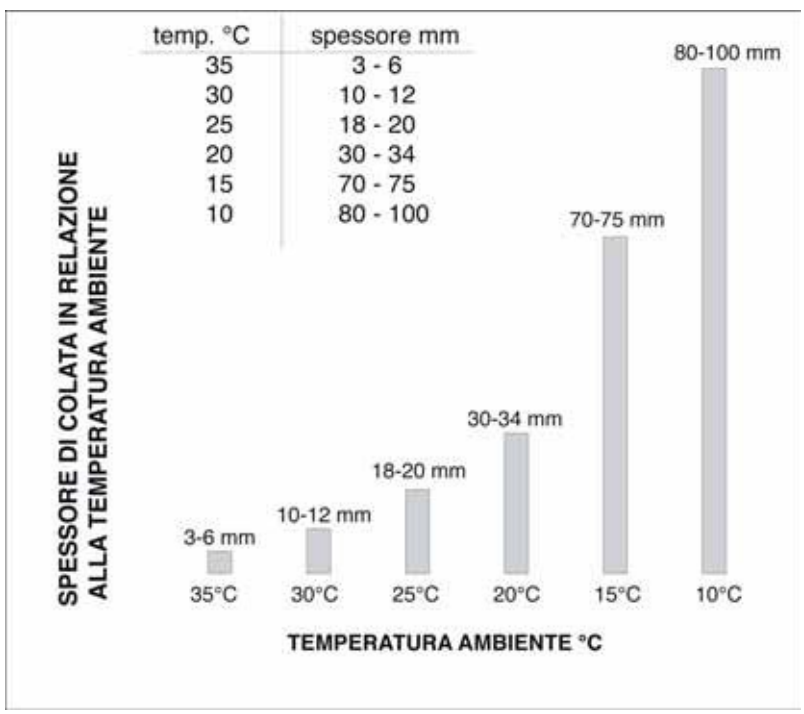
Maximum and minimum thickness of resin per layer depending on the ambient temperature. The casting thickness varies from a minimum of 3 mm "average" to a maximum of 100 - 120 mm, depending on the ambient temperature. Particular attention and precaution must be taken if you have large surfaces with small thicknesses.



35°C	=	3	-	6	mm
30°C	=	10	-	12	mm
25°C	=	18	-	20	mm
20°C	=	30	-	34	mm
15°C	=	70	-	75	mm
10°C	=	80	-	100	mm

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Greater thicknesses can usually be achieved in multiple stages, depending on the heat dispersion of the substrate. In the case of successive castings, the rule of thumb is to roughen the surface with a disk to create greater adhesion. Nothing is done after 8-10 hours of the same day.
If it stays overnight, it is necessary to remove any amines by always roughing and washing with warm water and drying.
For further information, please contact our technical office or submit the relevant drawing.

Compression values refer to the maximum operating temperature (CTS test report n°73313)
The maximum laboratory load, calculating the maximum operating temperature of 100°C is > 40 MPa/cm2, as a precaution we apply an ignorance-safety coefficient of (10 - ten), therefore we consider a value equal to 4 MPa/cm2.
The temperature of 100°C is found to be 25% higher than that of similar products. **STEEL Blue**.

Compression values referred to the maximum operating temperature:

STEEL Blue

TEMPERATURE OF TEST °C	BREAKING LOAD A COMPRESSION Rc (MPa)
30	140
50	126
70	103
80	81
90	58
100	42

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STEEL Blue

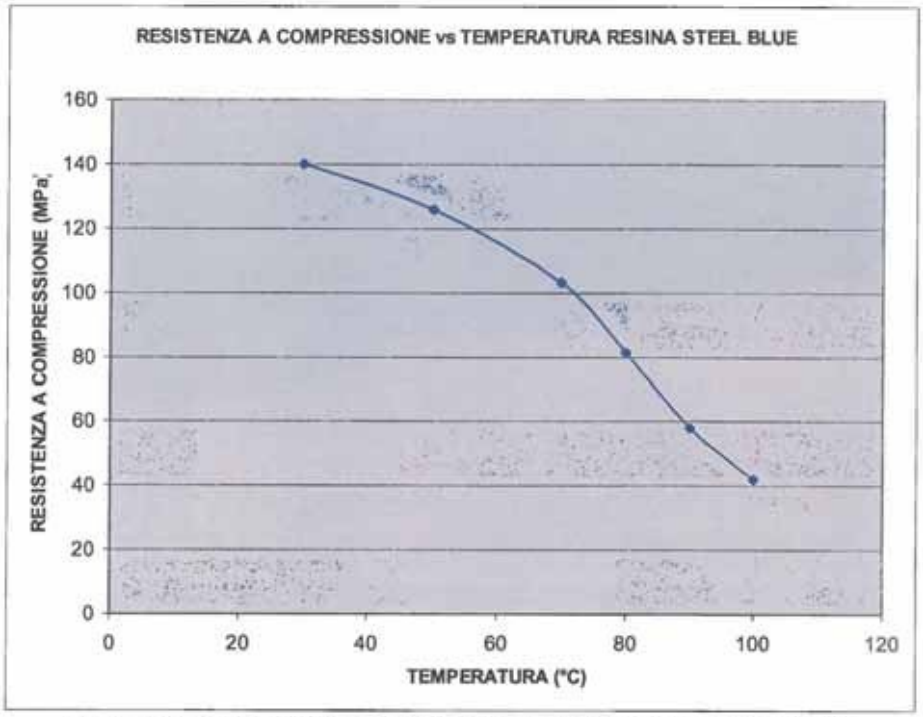

Fig. 1 – Diagramma carico di compressione – temperatura resina STEEL BLUE

The resin**STEEL Blue**at the test temperature of 80°C it provides a breaking load of 81 MPa, therefore with a margin approximately 16 times greater than that normally prescribed.

However, by conservatively introducing a safety coefficient equal to (10 -ten), the maximum compression values can be defined in relation to the different maximum operating temperatures.

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STEEL Blue

TEMPERATURE MAXIMUM OF EXERCISE °C	Limit value of compression Rc (MPa)
30	14
50	13
70	10
80	8
90	6
100	4

CALCULATION – ALIGNED BASE

1. The stress on the resin element is due to the weight of the equipment / engine, is defined as “Deadweight Loading”, may have limitations based on the requirements of the Classification Society and must be determined before the design of the structure.

Reference values for “Deadweight Loading” defined by the Classification Regulations are between 0.7 MPa * (70 N/cm^2) and 0.9 MPa * (90 N/cm^2).

2. When designing a aligned crankcase, the minimum required base area (Minimum Required Chock Area) must first be calculated. This will be calculated by dividing the weight of the equipment/engine (complete with accessories, internal fluids, etc.) by the allowable stress (Allowed Deadweight Loading). Please note that this is the MINIMUM acceptable area.

[Equipment / Motor Weight] ÷ [Maximum Allowable Flow Rate] = [Minimum Required Area – Resin]
(N) (N / mm 2) (mm^2)

3. Typically, resin elements are designed to withstand a maximum stress value of 3.4 MPa under precisely aligned conditions; however, stress values of 4.41 MPa can be accepted up to temperatures of the order of 80 °C.

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4. The permissible stress value of the connecting bolts is obtained by subtracting the contact pressure value (Deadweight Loading) from the maximum permissible stress value (generally a requirement of 441 N/cm 2).

[Maximum permissible static stress] – [Actual load capacity] = [Permissible bolt stress]
(N / mm 2) (N / mm 2) (N / mm 2)

5. Dividing the allowable stress by the number of actual bolts gives the axial load of the single bolt.

[Allowable Bolt Stress] ÷ [Number of Bolts] = [Bolt Stress]
N) (N)

6. To ensure that the equipment/motor does not tend to move, the stress on the bolt must be at least 2.5 times the weight of the equipment. At the same time, to ensure that the bolts remain under tension, the axial stress on the bolts themselves must be at least 46 ÷ 47 MPa.

7. Finally, to calculate the required tightening torque, the following formula can be used:

$$\text{Tightening torque (Nm)} = \frac{0.2 \times [\text{Bolt Axial Load}] \times [\text{Bolt Diameter}]}{1000}$$

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The tightening torque obtained must be greater than the value reported in the following Table 1 (used as a reference). (*_**Note**_MPa = N / mm^2)

Bolt mm	Step mm	Hex head. mm	Class / minimum torque (N·m)				
			4.6	6.8	8.8	10.9	12.9
3	0.5	5.5	0.51	1.01	**1.35**	1.90	2.27
4	0.7	7	0.95	1.91	**2.54**	3.57	4.29
5	0.8	8	2.28	4.56	**6.09**	8.56	10.3
6	1.0	10	3.92	7.85	**10.5**	14.7	17.7
8	1.25	13	9.48	18.9	**25.3**	35.5	42.7
10	1.5	17	19.1	38.1	**50.9**	71.5	86.8
12	1.75	19	32.6	65.1	**86.9**	122	146
14	2.0	22	51.9	104	**139**	195	234
16	2.0	24	79.9	160	**213**	299	359
18	2.5	27	110	220	**293**	413	495
20	2.5	30	156	312	**416**	585	702
22	2.5	32	211	422	**563**	792	950
24	3.0	36	270	539	**719**	1010	1213
27	3.0	41	398	795	**1060**	1490	1789
30	3.5	46	540	1080	**1440**	2025	2430

STANDARD BOLT TIGHTENING TORQUE

[Standard tightening torque for bolts]

(from www.wtools.com.tw)

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CALCULATION EXAMPLE REFERRING TO A 16-CYLINDER 2600 HP ENGINE

Below is a calculation example that allows you to recognize the different characteristics that must be considered when designing a resin structure for correctly aligned equipment / motors.

Engine Model

16 V 2000	weight	4052 kg (39750 N)

Characteristics of the supports

number of support plates	4
bearing plate surface	18 cm x 30 cm

Bolt characteristics

Resistance class	8.8
Number of bolts per support	4
Bolt diameter	14
Hole diameter on plate	16

Calculating contact pressure

Total area of the plates	2160 cm2
Hole area	32.15 cm2
Net area of the plates	2127.85 cm 2ˆ
Contact pressure	18.68 N / cmˆ2

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TYPICAL GENERAL REQUIREMENTS FROM THE CLASSIFICATION REGULATIONS

- **Maximum contact pressure =**0.9 N / mm^2 (90 N / cm^2)
- **Maximum total static stress =**4.41 N / mm^2 (441 N / cm^2)

From the above calculations we observe the following:

Actual contact pressure = (Equipment weight - motor) / (Net area of plates)

= 39750 / 2127.85

= 18.68 N / cm^2<90 N / cm^2 [satisfies]

DETERMINATIONS - INTEREST CHECKS IN THE DESIGN PHASE

1 -Determination of minimum contact area required

(Equipment weight - motor) / (maximum permissible contact pressure)

39750 / 90 ~ 442 cm 2^<[net area of plates = 2127.85 cm 2^] [satisfies]

2 -Determination of total bolt stress

(Maximum static stress) - (actual contact pressure)

441 - 18.68 = 422.32 N / cm 2^

Axial load on the net mating surface

422.32 x 2127.85 ~ 898634 N

Single bolt axial load

898634 / 16 ~ 56165 N

corresponding to a stress s = Axial load / resistant section

= 56165 / 153.86

= 365 N / mm^2 < $s_{b,adm}$= 373 N / mm^2

(see following table - permissible stress values for screw resistance class)

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Note : the determination made verifies the correct choice of material for the bolts.

Tensione ammissibile					
Classe vite	f_t N/mm²	f_y N/mm²	$f_{k,N}$ N/mm²	$\sigma_{b,adm}$ N/mm²	$\tau_{b,adm}$ N/mm²
4.6	400	240	240	160	113
5.6	500	300	300	200	141
6.6	600	360	360	240	170
8.8	800	640	560	373	264
10.9	1 000	900	700	467	330

$f_{k,N}$ è assunto pari al minore dei due valori $f_{k,N} = 0{,}7\, f_t$. $f_{k,N} = f_y$ essendo f_t ed f_y le tensioni di rottura e di snervamento secondo UNI 3740.

$\sigma_{b,adm}$. $\tau_{b,adm}$ tensioni ammissibili a trazione ed a taglio.

Extract from CNR UNI 10011
Steel Construction. Instructions for Design, Construction, Testing, and Maintenance.

3 -Checking the fixing condition

Axial load on the net mating surface > 2.5 x Weight

engine equipment

898634 > 2.5 x 39750 = 99375 [satisfies]

4-Checking the bolt stress condition to ensure the connection

Bolt stress > [46 ÷ 47] MPa (see page 1/5 point 6)

365 > [46 ÷ 47] MPa [satisfies]

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5 -Determination of tightening torque

Use the formula for calculating the torque indicated on page 1/5 point 7, reported below and check the value obtained with the reference table data on page 2/5

$$\text{Tightening torque (Nm)} = \frac{0.2 \times [\text{Bolt Axial Load}] \times [\text{Bolt Diameter}]}{1000}$$

Torque = (0.2 x 56165 x 14) / 1000 ~ 157 Nm > 139 (table) [satisfies]

6 -Determination of the total volume of resin

To calculate the total volume of resin to be used, once the cross-sections of the individual supports are known and the thickness has been determined, the net volume of the resin can be calculated. It will also be necessary to consider an increase of ~ 5 ÷ 10% to take into account any processing waste, overlaps, etc.

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TESTS AND CHECKS CARRIED OUT - RELEVANT RESULTS

Technical characteristics carried out at CTS - Experimental Technology Center of La Spezia – ITALY.

Chemical-physical characterization

Types of analyses carried out, the test conditions with the equipment used and the relative results obtained.

In particular, the following determinations were made:

o Determination of the initial viscosity of the mixture at 25°C [ASTM D 2196]; o Determination of the exothermic peak of the mixture;
o Determination of the glass transition temperature (Tg) [ASTM D 3412]; o Determination of the coefficient of linear thermal expansion [ASTM D 696]; o Determination of abrasion resistance by the TABER method [ASTM D 4060]; o Determination of volume resistivity [DIN 53482];
o Determination of dielectric strength [DIN 53481];
o Determination of linear shrinkage at 25°C after 7 days [ASTM D 2566].
o Pull Out Test - extraction tests of bolts inserted inside the resin:
- M24 bolt - depth 45mm [11175 daN]
- M24 bolt - depth 25mm [2585 daN] The

significant results obtained are summarised:

SAMPLE C – SYSTEMS STEEL Blue PARAMETER	UNIT OF MEASUREMENT	VALUE
Mixture viscosity at 25°C	mPas	7000
Exothermic peak		41.2
Glass transition temperature (1st - 2nd scan)	°C	62 - 67
Thermal expansion coefficient (Tg -10°C)	°C	28.2x10^-6
Coefficient of thermal expansion (Tg +10°C)	1 / °C	98.6x10^-6
TABER index by weight	1 / °C	0.61
TABER index in volume		0.34
Volume resistivity		5 x 10^14 -
Dielectric strength	Ohm x cm	21.13 -
Linear withdrawal	kV / mm	0.04
	%	

FLUID RESISTANCE PARAMETER	UNIT OF MEASUREMENT	VALUE
Water absorption (72h - 25°C) Immersion	% (weight gain)	0.04
in sea water (7 days – 25°C) * Immersion in	% (weight gain)	0.015
diesel (7 days – 25°C) *	% (weight gain)	0.016

* Note: at the end of the immersion period both in sea water and in diesel fuel the samples did not show any significant detachments – flaking – softening and/or deformations

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MECHANICAL TESTS

PARAMETER	UNIT OF MEASUREMENT	VALUE
Hardness	Shore D	93
Hardness	Barcol	Min 45(fully cured)

SAMPLE AS IS

PARAMETER	UNIT OF MEASURE	VALUE
Tensile breaking load Tensile	MPa	56
modulus of elasticity	MPa	15883
Unit breaking load in bending	MPa	119
Elastic modulus in bending	MPa	12511
Compression tensile strength	MPa	130
Compression modulus of elasticity	MPa	12106

SAMPLE AGED IN SEA WATER PARAMETER

	UNIT OF MEASURE	VALUE
Tensile breaking load Tensile	MPa	51
modulus of elasticity	MPa	14552
Unit breaking load in bending	MPa	105
Elastic modulus in bending	MPa	10842
Compression tensile strength	MPa	127
Compression modulus of elasticity	MPa	14217

SAMPLE AGED IN DIESEL PARAMETER

	UNIT OF MEASURE	VALUE
Tensile breaking load Tensile	MPa	54
modulus of elasticity	MPa	14451
Unit breaking load in bending	MPa	94
Elastic modulus in bending	MPa	10838
Unit compressive strength	MPa	125
Elastic modulus in compression	MPa	12227

SAMPLE AS IS

PARAMETER	UNIT OF MEASURE	VALUE
Charpy impact strength	J	0.47

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SAMPLE AGED IN DIESEL Charpy impact strength **PARAMETER**	J	0.53
	UNIT OF MEASURE	**VALUE**
Inflection temperature	°C	58

FIRE BEHAVIOR

PARAMETER	**Observations**
Flame Ignition	In all tests carried out, always 78 seconds at first ignition
Average burn time Burn length	In all tests carried out always less than 2.54 cm

Based on the results of the flammability tests, the material examined is declared "SELF-EXTINGUISHING" for the test conducted according to the requirements of the ASTM D 635 standard.

For the following tests, see attached TEST REPORT 73313 - 78912 - 278914 "Tests and checks on the two-component epoxy system STEEL Blue" drawn up by CTS - Experimental Technology Centre of La Spezia – ITALY

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TEST EXTRACTION OF BOLTS INSERTED INSIDE THE RESIN (PULL OUT TEST)

Particolare della disposizione del campione di resina per prova PULL OUT (M24 – H 45mm).

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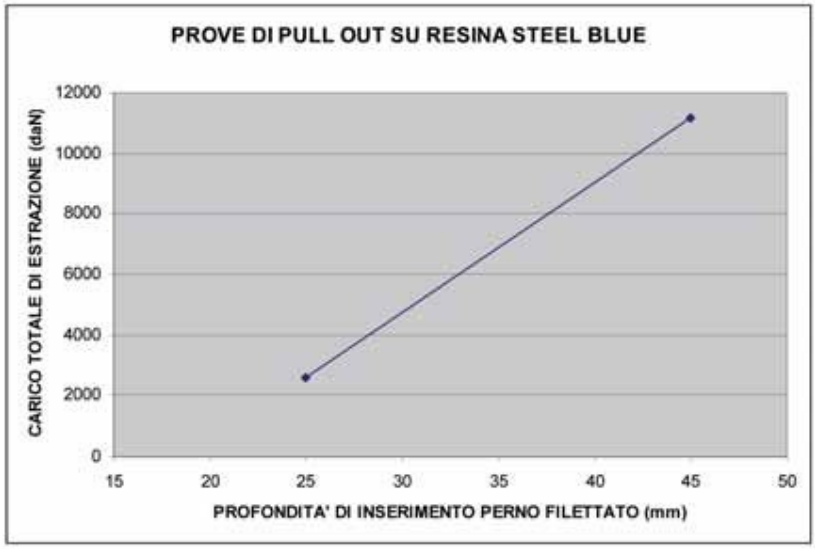
Nella seguente tabella vengono riportati i risultati ottenuti

PROVETTA	CARICO TOTALE DI ESTRAZIONE (daN)
P01 [M24 – H45]	11175
P02 [M24 – H25]	2585

Nel seguente diagramma viene rappresentato l'andamento del carico totale di estrazione in funzione della profondità di inserimento dell'elemento filettato nello spessore di resina.



Andamento della forza di estrazione al variare della profondità di inserimento del perno fielletato.

Aspetto dei campioni [M24 – H45] e [M24 – H25] dopo prova di PULL OUT.

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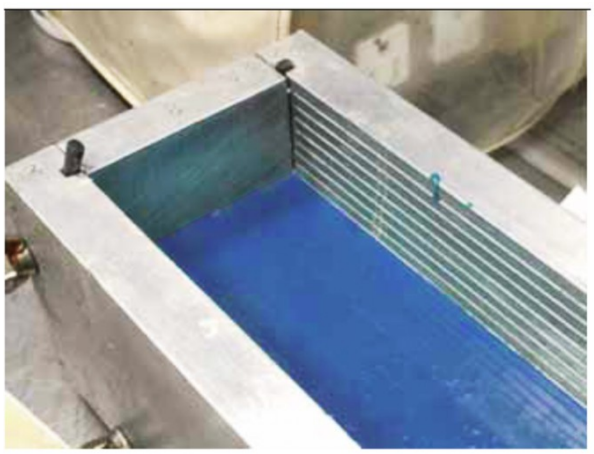
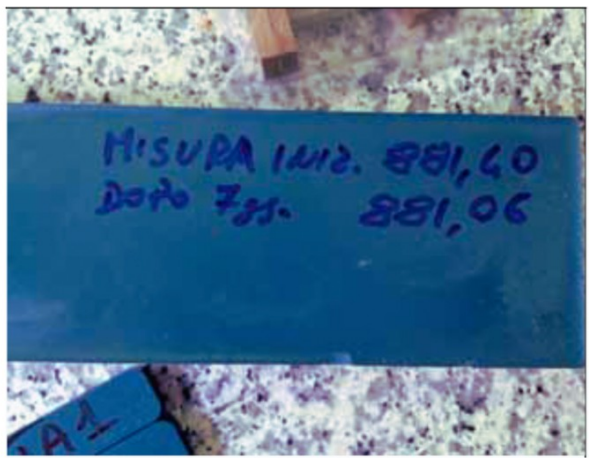
DETERMINATION OF LINEAR SHRINKAGE AT 25°C AFTER 7 DAYS (ASTM D 2566)





C-SYSTEMS STEEL Blue CHAMPION

PARAMETER	UNIT OF MEASUREMENT	VALUE
Linear withdrawal	%	0.04

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ASTM D-2583 BARCOL HARDNESS TEST

CAMPIONI COME PERVENUTI

METODO/I DI PROVA - Test method(s): ASTM D 2583 : 13
Specifiche di rif.to-Reference standards: ---
STRUMENTI - Equipment: A30 - GYZJ 934 - 1 DATA DI ESECUZIONE-Test date: 07.11.2017
NOTE - Notes

N° prova Test n°	Temp. Temp.	PROVA DI TRAZIONE A TEMPERATURA AMBIENTE - *Room Temperature Tensile test* Dimensioni provette Specimens dimensions			Rottura Tensile Strength-TS		Snervamento Yield Strength-YS		Allungam. Elongation after fr.-E	Strizione Reduct. of area - RA	Prova di durezza Hardness test	Prova di schiacciamento Flattening test
		Ø / a x b	L_o	Area (S_o)							BARCOL	
	°C	mm	mm	mm^2	kN	MPa	MPa	MPa	%	%	Result	Result
1	Ambiente										48 - 48 - 50	
2	Ambiente										45 - 48 - 45	
3	Ambiente										50 - 48 - 50	
4	Ambiente										50 - 48 - 48	
5	Ambiente										50 - 50 - 48	
										MEDIA	48	
VALORI RICHIESTI	min											
Required values	max											

PROVA DI RESILIENZA - *Impact test*

METODO/I DI PROVA - Test method(s):
Specifiche di rif.to-Reference standards:
STRUMENTI - Equipment: DATA DI ESECUZIONE-Test date:
NOTE - Notes

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TEST FOR TIGHTENING M12 AND M36 BOLT WITH TORQUE WRENCH

Particolare della disposizione di prova per serraggio bullone M12.

Particolare della disposizione di prova per serraggio bullone M36.

After reaching the expected tightening torque, each sample was left in position for at least 2 minutes. At the end of the test and after dismantling the equipment, the central drilled areas of each resin sample were inspected and documented again.

In no case were deformations and/or macroscopic lesions of the material observed.

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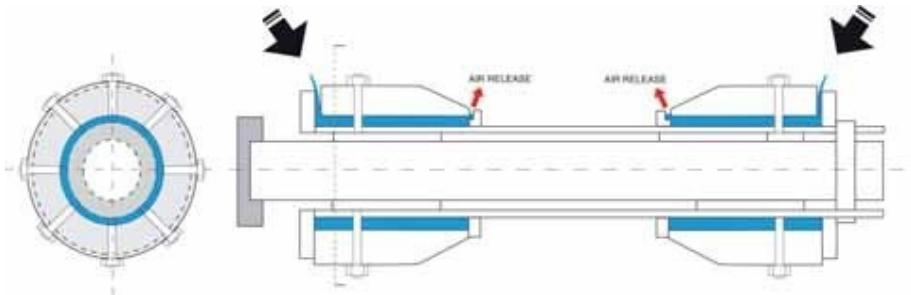
Appearance of the central perforated areas of the individual samples after compression testing by tightening the bolts.

EXAMPLES OF SHAPES - CROSS-SECTION VIEWS OF THE INTERVENTION AREAS



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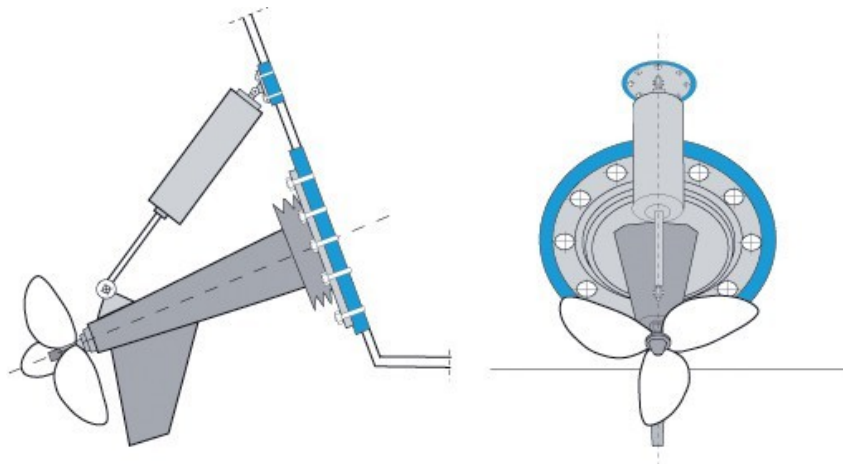

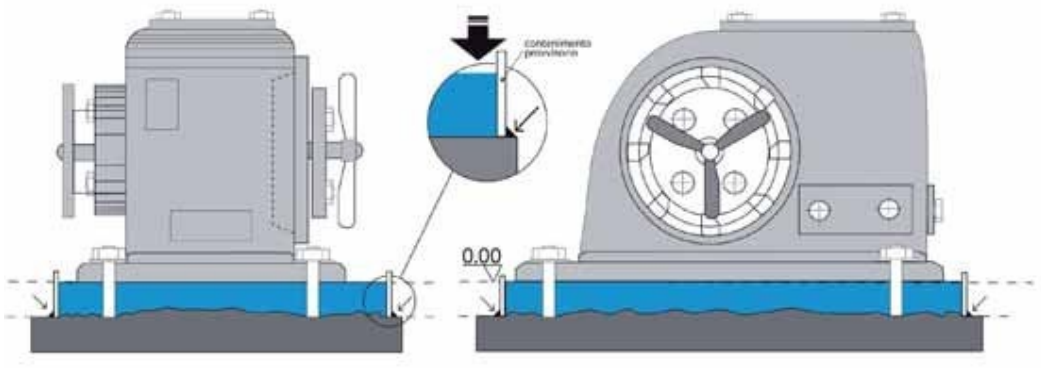

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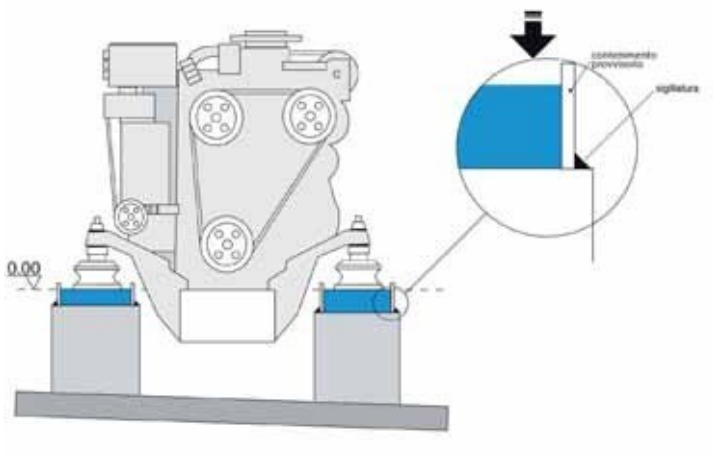

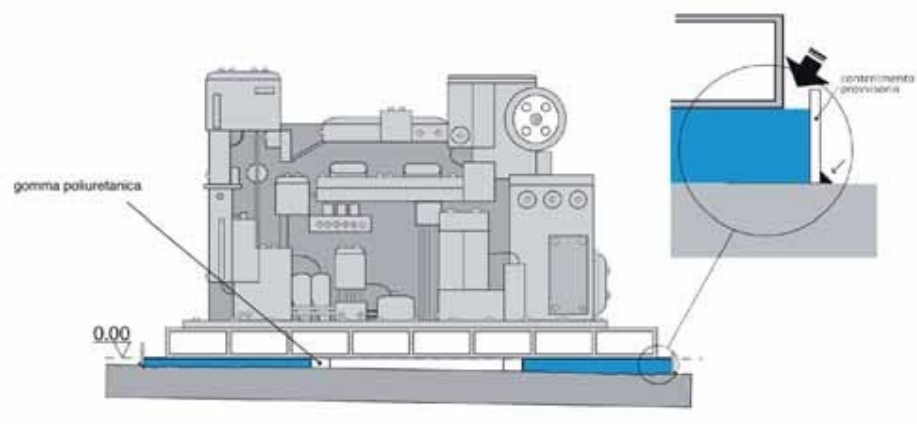

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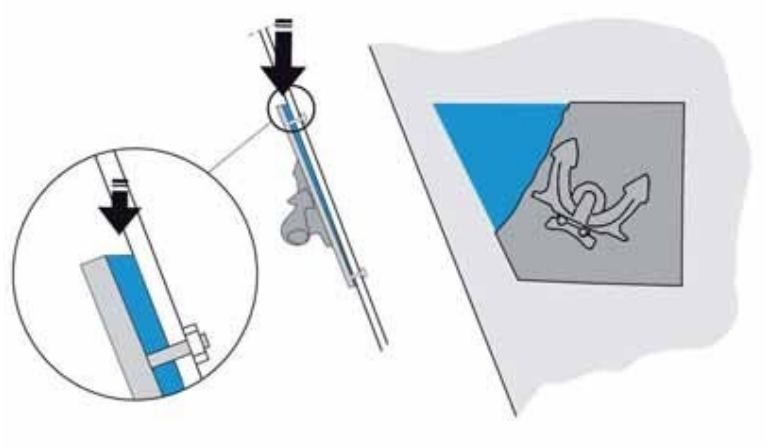

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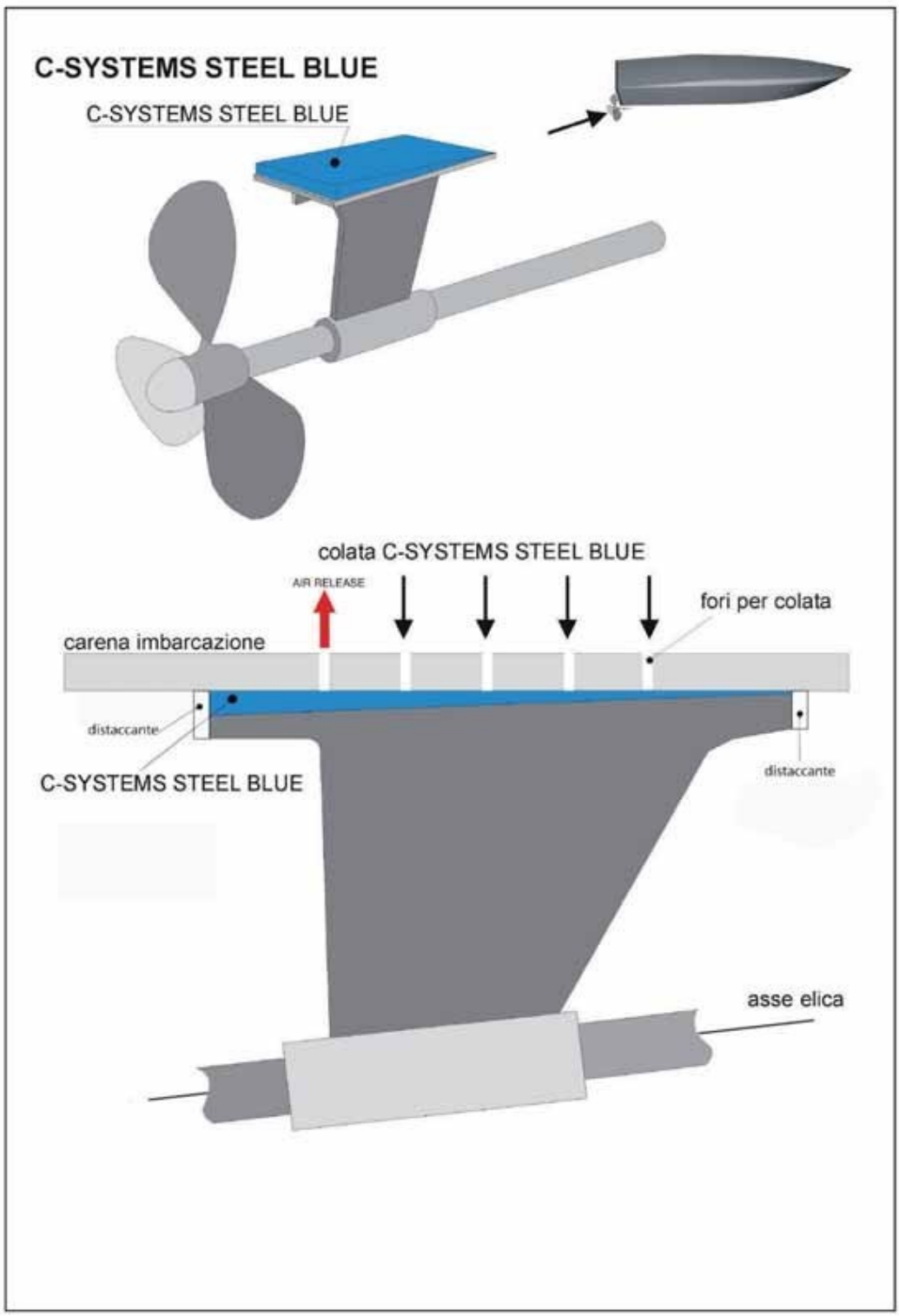

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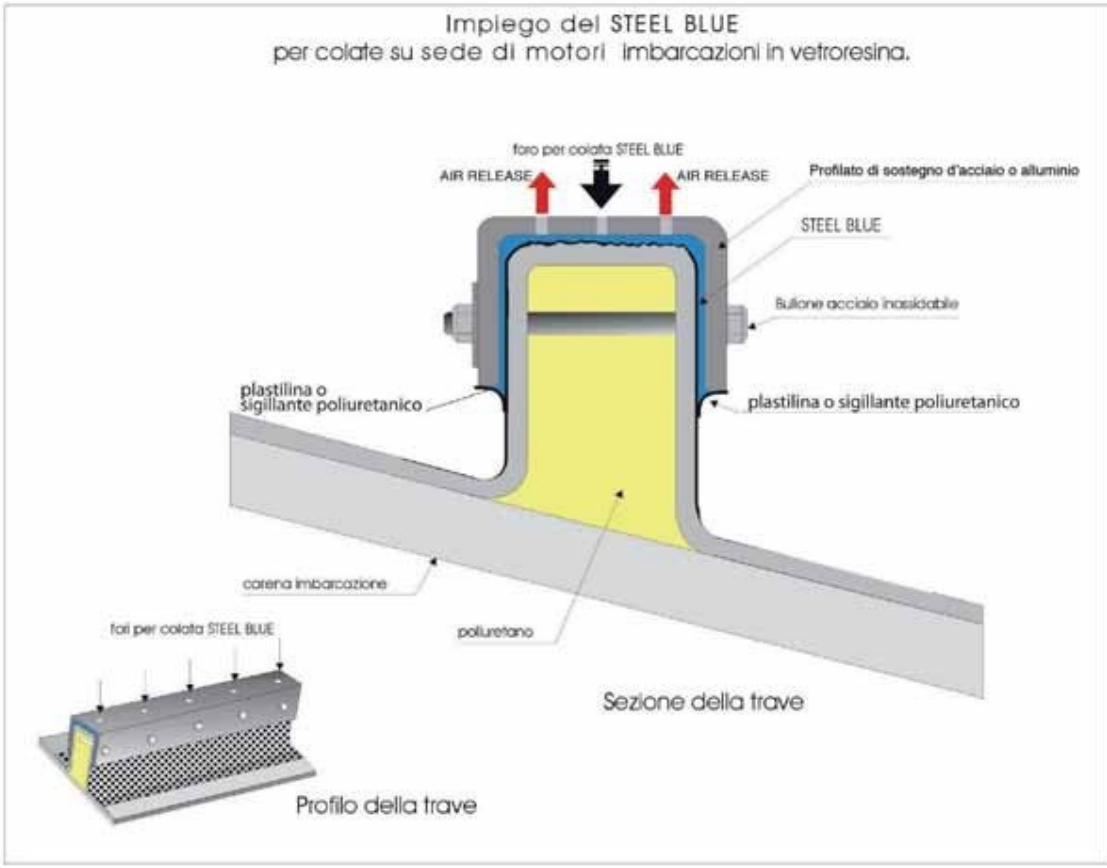

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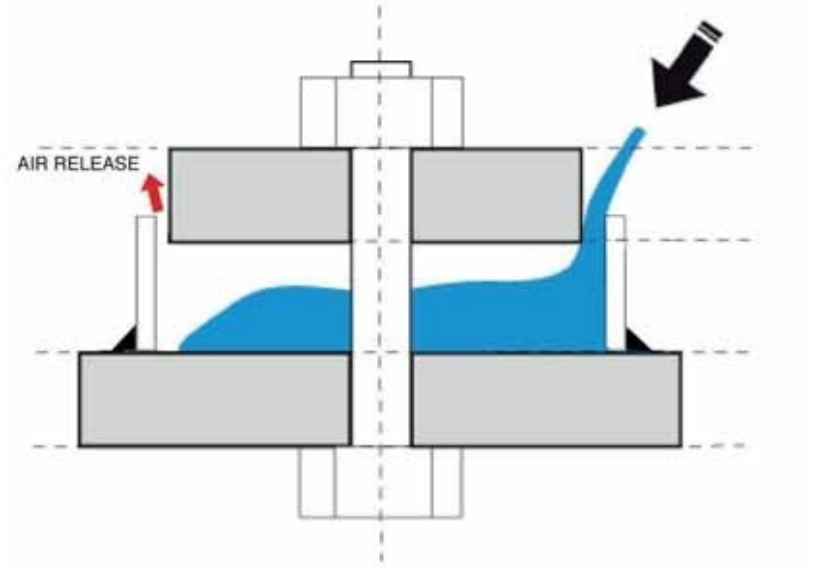

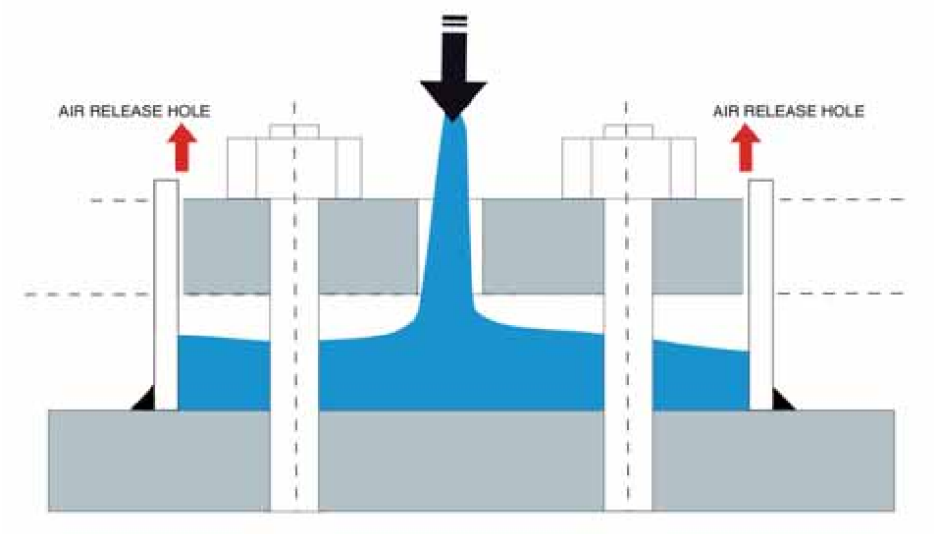

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