STEEL BLUE® colour Blue & Yellow

Epoxy Chocking Compound Resin

DESCRIPTION

C-Systems **STEEL Blue** is a two-component epoxy developed and formulated for alignment, incorporation, both in the marine, industrial and technical sector.
STEEL Blue is filled with inert materials, solvent free, 100% solid content (no shrinking), **STEEL Blue** has a very high compressive strength, thermal shock resistance, and high resistance even under extreme conditions such as crash, vibration, traction, or in presence of water and oils.
STEEL Blue creates the chock, a perfect support for the alignment without needing the classic metal wedges which instead require skilled labor and a long period of running.
STEEL Blue, at the same time, offers a perfect and permanent support interface.
STEEL Blue has practically no shrinkage.
ASTM D 2566 - shows on a length of 881.4 mm with a thickness of 30 mm after 7 days aging at 25° C constant, a shrinkage of 0,04% equal to 881,06 mm. Length and height were laser measured.
STEEL Blue is partner of many shipyards and industrial sites, recommended by technical operators.
STELL Blue has a widespread capacity to precisely and quickly conform to the smallest details and to fill the smallest cleft.

USE & ADVANTAGES

The choice, reliability and advantages of **STEEL Blue** are due to:
Technical features
Easy preparation
Easy application
Availability
Fast shipment
Technical assistance, also by phone

STEEL Blue was developed to fill, leveling, align, casting main machines and supports.
STEEL Blue is designed to create engines basements also with differentiated supports, generators, gear boxes, inverters, strut, surface drives support, sail drive alignment, through-hull stern tubes shaft, winches, interface for chain plates joints, interface for bulbs and keels, interface for anchors shields, etc.

Temperature of application = > 8C° up to 35°C
Store **STEEL Blue** (resin A+ hardener B) at a temperature not lower than 10C°. Relative humidity max 90%.
To ensure a good mixing and viscosity during the application store it in a warm environment or use heaters, oil heaters or other heating sources in order to warm-up it homogeneously.
After the application keep the temperature beyond the minimum required values.

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Minimum gelling time

Gelling time at 25 ° C	2,5 - 3,5 hours thickness of about 50 mm
Gelling time at 10 ° C	7,0 - 8,0 hours thickness of about 50 mm

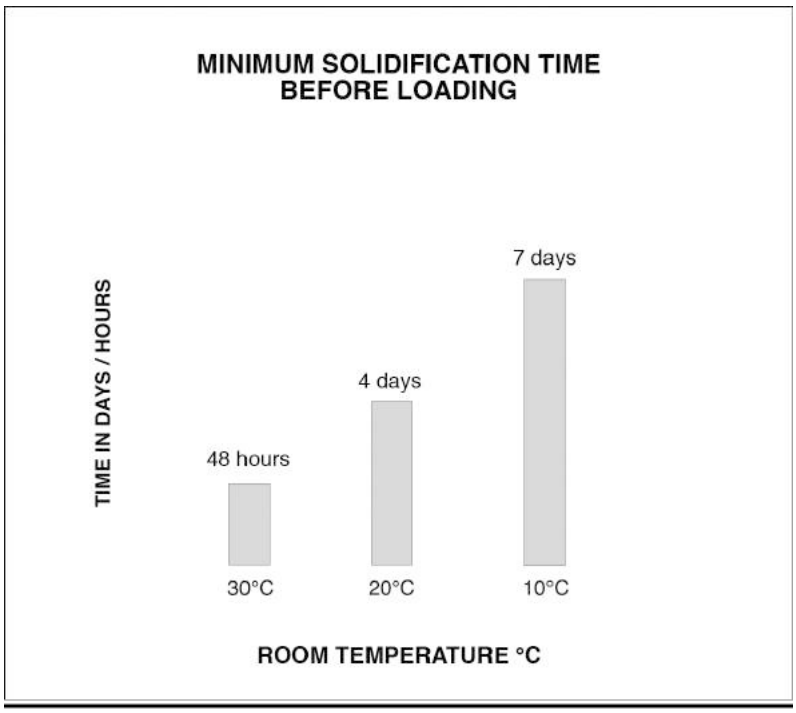
Maximum value of the operating temperature

(Test report CTS No. 73313)

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

Minimum solidification time before loading / clamping bolts with a torque wrench:

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



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TECHNICAL DATA

PACKAGE (Volume per unit)

Resin	component A	can	8.535 kg	(4289 l)
Hardener	component B	can	0.475 kg	(0,540 l)
Total Weight	(A+B)		9,010 kg	
Total Volume	(A+B)			(4,829 l)

Component B contained in the can is slightly in excess if we consider the 5%, because it has been also calculated the residual that remains inside.
If the product is correctly poured, the excess will help the reticulation of the product during the winter at temperature below 15°C.
The excess of hardener respects the tolerances calculated and required.
In the Yellow version the hardener is Red colored, it allows to better recognize if component A (resin - yellow colored) and component B (hardener - red colored) are properly mixed.

MAIN FEATURES OF THE SYSTE

RESIN

Color		Blue	
Density at 25°C	ASTM D1475	g/ml	1,97 - 2,01
Viscosity at 25°C		mPas	80.000 - 130.000

HARDENER

Color		yellow	
Density at 25°C	ASTM D1475	g/ml	0,86 - 0,90
Viscosity at 25°C		mPas	5 - 10

USING DATA

Mixing ratio by weight for 100 g of resin	g	100:5
Mixing ratio by volume for 100 ml of resin	ml	100:12
Pot life at 25°C (50 mm; 200 ml)	min	25:35

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INSTALLATION INSTRUCTIONS AND RECOMMENDATIONS FOR USE

Mix thoroughly for at least 2 minutes component A with the mixer supplied with **STEEL Blue** (maximum rpm150)
Mix well and pour component B into component A.
To perfectly homogenize the two components mix them for at least 5 minutes using a drill with a mixer at a speedness of about 80-150 (max) rpm, depending on the operating temperature.

To get the perfect mixing, the first pack of **STEEL Blue** also includes No. 1 (one) harmonic steel Mixer, specifically designed and shaped and sized, to be fasten to the drill with a power regulator.
For bigger orders has to be considered a Mixer every 10 packs.

STEEL Blue can be easily mixed even during winter due to the perfect harmonization of the inert materials; the addition of the hardener increases the fluidity of the compound. Operator has to follow the fixed value of the mixing ratio previously indicated.
The special shape of the mixer allows to reach the bottom of the package and its edges without scratching or jamming the rotation.

The container of Component A is generously dimensioned (more than 2 times its volume also calculating the component B), therefore raising the Mixer even during its dynamic work the material doesn't flows out thanks to the effect of centrifugal force.

STEEL Blue can be poured directly from its container or, if necessary due to lack of space, in a funnel connected to the area of intervention.
It is essential that the area to fill, however complex, respects the discharge of air in order to avoid any not properly filled areas, which in this case would put in evidence the not perfect support base. To facilitate drying use infrared lamps and dimmer for regulating the temperature during the winter, if necessary.

FOR INSTALLING STEEL Blue FOR FLAT AS WELL AS ROUND CHOCK INSTALLATION

To avoid any type of void created by the air the chock area should be properly designed before casting the **STEEL Blue**.
Remove traces of rust, oil, rest of merger, muds, mill scale, sand, burns and welding slag, flaking paints.
If the surfaces need to be protected from the rust, grind the surface and apply a coat of epoxy primer before the application.

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To have an easy release of the parts that should be removed in the future, these parts (such as bolts) should be sprayed with a release compound or treated with normal melted wax applied by brush.
Construction of the damming can be made with sections of wood or metal sheet stuck together with hot glue and finished off with rubber in cartridge to perfectly seal the edges or with an oil based putty.
The use of barriers mounted with plasticine or barriers to be maintained in position by a seal of polyurethane rubber in the cartridge, or the use of profiles or expanded rubber tapes with adhesive edges, are suitable to delimit and completely or partially circumscribe the area of intervention. A sealing procedure is also requested on the side of the resin exposed to sea water, (i.e. propeller bracket, anchor pocket plate).

For an alignment of 80 mm, the edges should be at least 100 - 120 mm high in order to perfectly pour **STEEL Blue**, even if applied in a quick and generous way, without making any spills.
It is advisable to pour **STEEL Blue** considering the size of the pouring after having calculated the volume adding a surplus of at least 5 - 10%.

USE OF RELEASERS
For an ease release of the damming after the application of the **STEEL Blue**, treat the damming surface with grease, wax based releaser or the melted wax of a candle applied by brush and other specific products such as **Lubrolene E6**, available in our line of products. This will enable the release of the damming after the operation.
For strut, flanges support, etc. provide the application of a release agent on one side of the chock to enable a possible future substitution.

Maximum and Minimum thickness of resin per pouring layer, as function of ambient temperature. The thickness per pouring layers varies from a minimum of average of 3 mm to a maximum of 100-120 mm as a function of ambient temperature. Particular attention and precaution must be kept in presence of large surfaces with small thickness chocks.

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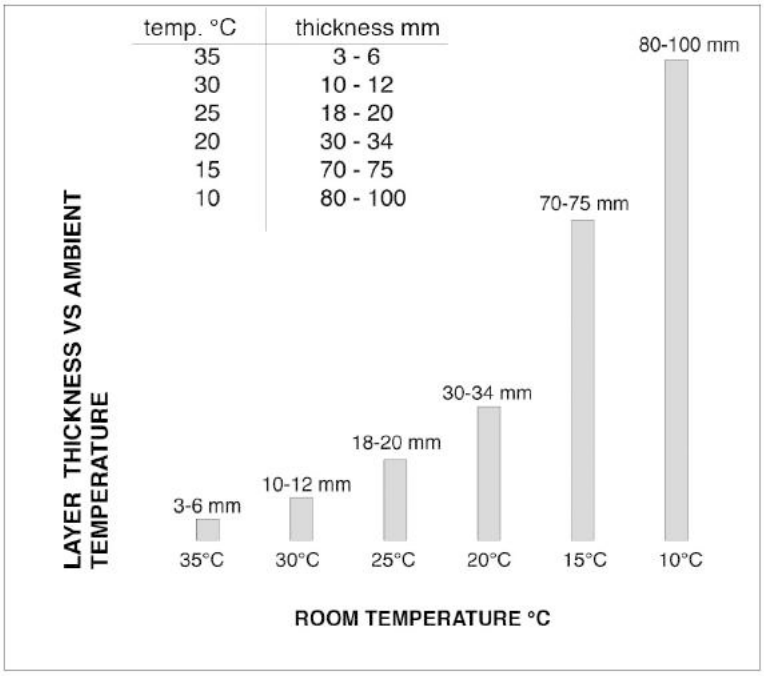

35°C	=	3	-	6	mm
30°C	=	10	-	12	mm
25°C	=	18	-	20	mm
20°C	=	30	-	34	mm
15°C	=	70	-	75	mm
10°C	=	80	-	100	mm

Higher thicknesses can be routinely achieved in stages and are also related to thermal dispersion of the support: in the case of successive castings it is more advisable to rough cut the surface with a grinder to create greater adhesion. The surface cannot be touch in the 8-10 h after the application.
If it passes the night is necessary to remove the presence of blush amine always using the grinder and washing the surface with warm water and after dry-up.
For related information, please contact our technical department or submit the project.

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Value of compression at maximum operating temperature
(Test report CTS No. 73313)
Maximum load of laboratory, calculating the maximum operating temperature of 100 °C is > 40 MPa/cm^2, it is precautionary taken in consideration a safety coefficient of (10- Ten).
We consider then a value of 4 MPa/cm^2.

The temperature of 100 ° C achieved with **STEEL Blue** is higher of 25% if compared to similar products.

Value of compression referred to maximum operating temperature:

STEEL Blue

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

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STEEL Blue

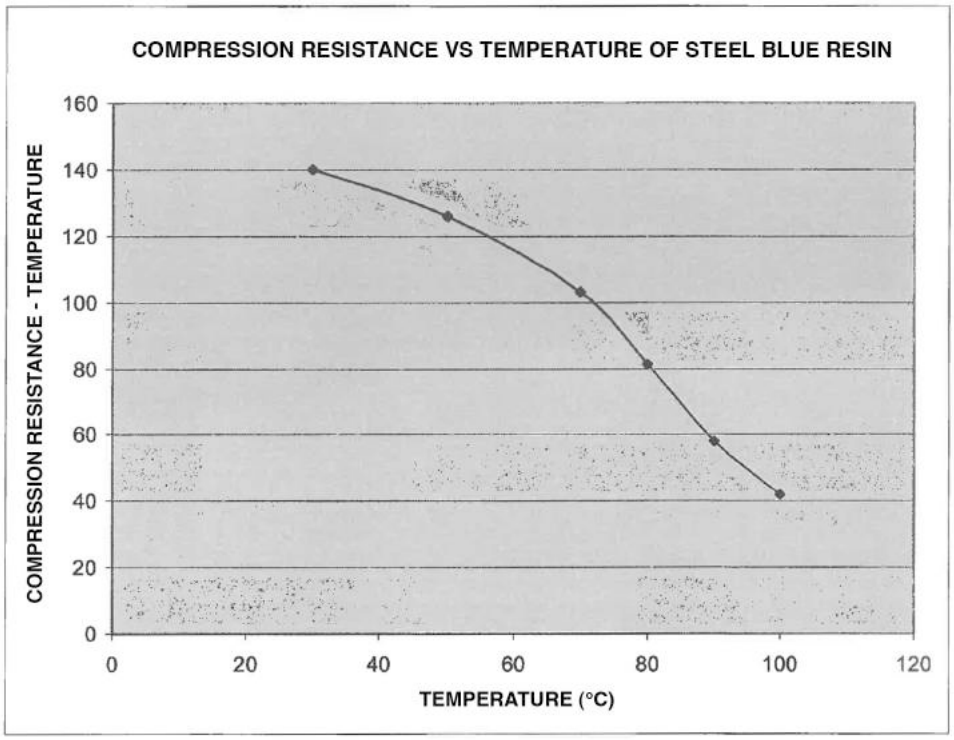

Diagram load of compression - temperature of Steel Blue Resin

STEEL Blue resin in correspondence with the test temperature of 80 ° C provides a breaking load of 81 MPa, therefore with a margin of approximately more than 16 times if compared to that normally prescribed.

However, introducing a conservative level a safety factor of 10 can be considered the maximum compression referring to various maximum permissible operating temperatures.

STEEL Blue

Maximum Operating Temperature°C	Limit value of compression Rc (MPa)
30	14
50	13
70	10
80	8
90	6
100	4

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CALCULATION – ALIGNEMENT BASEMENT

1. The stress on the resin element is created by the equipment /engine weight and it is known as “Deadweight Loading”. It can be limited according to the prescription given by the Vessel’s classification society before the determination of the structure. The reference of the “Deadweight Loading” that has to be taken is the one defined by the Vessel’s Classification Society: from 0,7 MPa * (70 N / cm^2) to 0,9 MPa * (90 N / cm^2).

2. For the design of the basement the first details to be known is the “Minimum Required Chock Area”. To do that it has to be defined the Total Weight of the Machinery (including the accessories, internal liquids...), this value will be divided by the “Allowed Deadweight Loading”

Total Weight of the Machinery/Engine	**÷**	**Maximum Allowed Deadweight Loading**	**=**	**Minimum requested Area – Resin**
(N)		**N / mm^2)**		**(mm^2)**

3. On chocks of resin for a precise aligned machinery element are commonly designed to tolerate a maximum stress of 3,4 MPa, they can still be accepted stress values of 4.41 MPa up to temperatures of 80 ° C.

4. Total Allowable Bolt Stress is calculated subtracting the Maximum Allowable Static Stress (generally required of Class 441 N / cm^2) from the Deadweight Loading:

Maximum Allowable Static Stress (N / mm^2)	**-**	**Deadweight Loading (N / mm^2)**	**=**	**Total Allowable Bolt Stress (N / mm^2)**

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5. Dividing the Total Allowable Bolt Stress by the number of bolts we define the Axial Tension per each bolt:

Total Allowable Bolt Stress (N)	**÷**	**Number of Bolts**	**=**	**Axial Tension per each Bolt (N)**

6. In order to be sure that the machinery/engine will not move, bolt tension in total should be at least 2,5 times the weight of the machinery/engine. At the same time to ensure bolt remain tight, axial tension of the bolts should be at least 46 ÷ 47 MPa.

7. To determine the required Bolt Torque use the following formula:

$$\text{Bolt Torque (Nm)} = \frac{0{,}2 \times [\text{Bolt Axial Tension}] \times [\text{Bolt Diameter}]}{1000}$$

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Bolt Torque defined by the above-mentioned formula should be higher of the value listed in the following schedule no. 1 (used as reference)
(* MPa = N / mm^2)

Bolt Size mm	Pitch mm	Bolt Hex	Strenght Grade (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
(www.wtools.com.tw)

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CALCULATION FOR A 16 CILINDERS 2600 HP ENGINE

In the following is proposed an example of a calculation that allows to recognize the different characteristics that have to be considered for designing a resin structure for properly aligned equipment /engine.

Engine Model		
16 V 2000	weight	4052 kg (39750 N)
Characteristic of the supports		
	Support plates number	4
	Surface support plate	18 cm x 30 cm
Characteristic of bolts		
	Strength grade	8.8
	Number of bolts per support	4
	Diameter bolt	14
	Diameter hole on the plate	16
Evaluation of the Deadweight loading		
	Total plates area	2160 cm^2
	Holes area	32,15 cm^2
	Net plates area	2127,85 cm^2
	Deadweight loading	18,68 N / cm^2

CONDITIONS REQUIRED BY THE CLASSIFICATION SOCIETIES

- **Max Deadweight loading** = 0,9 N / mm^2 (90 N / cm^2)
- **Max Total Static Stress** = 4,41 N / mm^2 (441 N / cm^2)

From the previous evaluation, the following can be observed:

Effective Deadweight loading = (machinery/engine) / (Net plates area)
= 39750 / 2127,85
= 18,68 N / cm^2 < 90 N / cm^2 [fulfill]

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DETERMINATION – TEST DESIGN

1 – Determination of the minimum required structure area

(machinery- engine weight) / (max deadweight loading)

39750 / 90 ~ 442 cm^2 < [plates net area= 2127,85 cm^2] [fulfill]

2 – Determination of the total bolt stress

(Max total static stress) - (Effective Deadweight loading)
441 - 18,68 = 422,32 N / cm^2

Total Axial Bolt tension on the net surface
422,32 x 2127,85 ~ 898634 N

Axial Tension for each bolt
898634 / 16 ~ 56165 N
corresponding to a stress s□=□ Axial tension/ section resistance
= 56165 / 153,86
= 365 N / mm^2 < $s_{b,adm}$ = 373 N / mm^2

(see following table – acceptable tension for class of bolt, CNR UNI 10011)

Admissible Tension					
Class / screw	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

$f_{k,N}$ is assumed equal to the lower of the two values $f_{k,N} = 0,7\, f_t$. $f_{k,N} = f_y$ being f_t and f_y the breaking and yielding stresses as per UNI 3740

$\sigma_{b,adm}$, $\tau_{b,adm}$ admissible tension, traction and cut

3 – Verification of the fixing conditions

Total Axial Bolt tension on the net surface > 2,5 x Machinery Weight – Engine
898634 > 2,5 x 39750 = 99375 [fulfill]

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4 – Verification of the stress conditions of the bolt to guarantee the connection

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

365 > [46 ÷ 47] MPa [fulfill]

5 – Determination of the torque bolt

Use the formula for the calculation of the torque indicated at page 1/5 point 7, here below listed and then control the achieved value on the table at page 2/5.

$$\text{Bolt torque (Nm)} = \frac{0{,}2 \times [\text{Bolt Axial load}] \times [\text{Bolt Diameter}]}{1000}$$

Torque = (0,2 x 56165 x 14) / 1000 ~ 157 Nm > 139 (table) [fulfill]

6 – Determination of the total volume of the resin

For calculating the total volume of resin to use, if we know the sections of the single support and we already defined the thickness we can the define the net volume of the resin. It will be also be necessary to consider an increase of about ~ 12 ÷ 15% for the possible processing offcuts, overlaps etc.

TEST AND RESULTS

Technical features carried out by CTS – Centro Tecnologico Sperimentale
(La Spezia – Italy)

Physical and Chemical Properties

Type of analysis, test conditions, features

Determination of the initial density of the mix at 25°C [ASTM D 2196];

Determination of the exothermic peak of the mix;
Determination of the Glass transition (Tg) [ASTM D 3412];
Determination of the linear thermal expansion [ASTM D 696];
Determination of the TABER Index [ASTM D 4060];
Determination of the volume resistivity [DIN 53482];
Determination of the dielectric strength [DIN 53481];
Determination of the linear shrinkage at 25°C after 7 days [ASTM D 2566].

Features are resumed in the following results:

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PARAMETER	UNIT OF MEASURE	VALUE
Density of the mix at 25°C	mPas	7000
Exothermic peak	°C	41,2
Glass transition temperature (1°- 2° scan)	°C	62 – 67
Thermal expansion coefficient (Tg -10°C)	1/°C	28,2x10^-6
Thermal expansion coefficient (Tg +10°C)	1/°C	98,6x10^-6
TABER Index by weight		0,61
TABER Index by volume		0,34
Volume resistivity	Ohm x cm	5 x 10^14 -
Dielectric Strength	kV / mm	21,13 -
Linear shrinkage	%	0,04

FLUID RESISTANCE

PARAMETER	UNIT OF MEASURE	VALUE
Water absorption 0,04	72h - 25°C)	% (weight increase)
Sea water dipping 0,015	(7days – 25°C) *	% (weight increase)
Fuel dipping 0,016	(7days – 25°C) *	% (weight increase)

Note: at the end of the period of dipping in sea water and fuel specimens didn't show any kind of detachments - stripping - softening and / or significant deformations.

MECHANICAL TESTS

PROPERTY	UNIT OF MEAUSEREMENT	VALUE
Hardness	Shore D	93
Hardness	Barcol	Min 45 (fully cured)

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SAMPLE FULLY CURED

PROPERTY	UNIT OF MEAUSEREMENT	VALUE
Tensile strength	MPa	56
Tensile modulus of elasticity	MPa	15883
Flexural strength	MPa	119
Flexural modulus of elasticity	MPa	12511
Compressive strength	MPa	130
Compressive modulus of elasticity	MPa	12106

SEA WATER AGED SAMPLE

PROPERTY	UNIT OF MEAUSEREMENT	VALUE
Tensile strength	MPa	51
Tensile modulus of elasticity	MPa	14552
Flexural strength	MPa	105
Flexural modulus of elasticity	MPa	10842
Compressive strength	MPa	127
Compressive modulus of elasticity	MPa	14217

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FUEL AGED SAMPLE

PROPERTY	UNIT OF MEAUSEREMENT	VALUE
Tensile strength	MPa	54
Tensile modulus of elasticity	MPa	14451
Flexural strength	MPa	94
Flexural modulus of elasticity	MPa	10838
Compressive strength	MPa	125
Compressive modulus of elasticity	MPa	12227

SAMPLE FULLY CURED

PROPERTY	UNIT OF MEAUSEREMENT	VALUE
Charpy impact strength	J	0,47

FUEL AGED SAMPLE

Charpy impact strength	J	0,53

PROPERTY	UNIT OF MEAUSEREMENT	VALUE
Heat deflection temperature	°C	58

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FLAME TEST

PROPERTY	OBSERVATIONS
Flame start	In all the tests carried out at the first ignition
Burning mean time	78 seconds
Length burned	In all the tests carried out lower than 2,54 cm

The sample is judged to be SELF-EXTINGUISHING according to ASTM D 635.

Please see tests on the attached reports no. 73313 – 78912- 278914. Tests were carried out at CTS – Centro Tecnologico Sperimentale – La Spezia - Italy.

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(PULL OUT TEST)

Picture of the resin sample during the pull out test (M24 – H 45mm).

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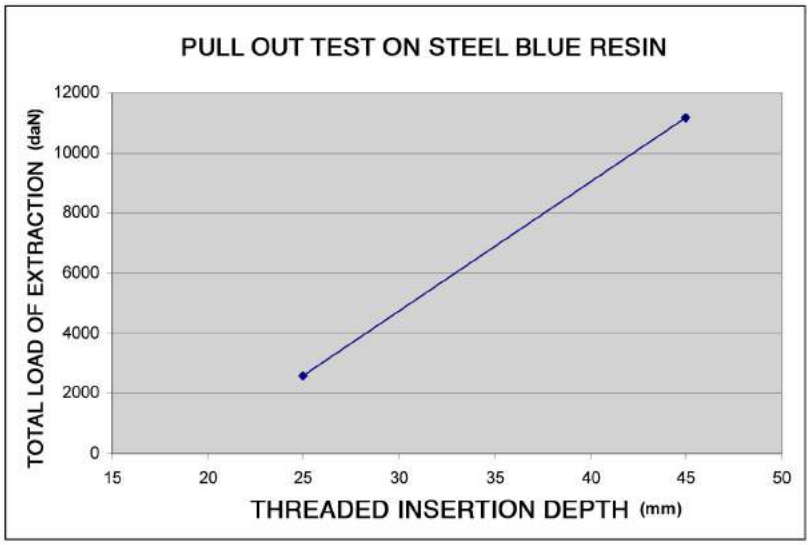
TEST CHART

SAMPLE	TOTAL LOAD OF EXTRACTION (daN)
P01 [M24 – H45]	11175
P02 [M24 – H25]	2585

Diagram representing the total loading in VS extraction depth



picture showing the sample after the pull out text

Sample M 24 - H45 and M24-H25 after the pull out test

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ASTM D-2583 BARCOL HARDNESS

CAMPIONI COME PERVENUTI

CENTRO TECNOLOGICO SPERIMENTALE CEPARANA (SP)

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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*									Prova di durezza Hardness test	Prova di schiacciamento Flattening test
		Dimensioni provette Specimens dimensions			Rottura Tensile Strength-TS		Snervamento Yield Strength-YS		Allungam. Elongation after fr.-E	Strizione Reduct. of area - RA		
		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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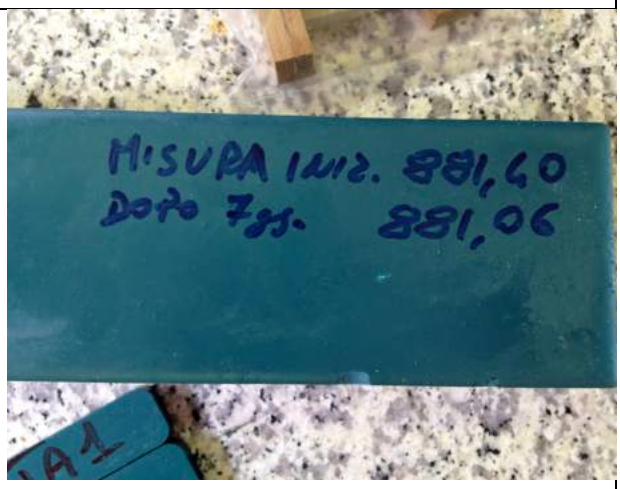
Determination of LINEAR SHRINKAGE at 25°C after 7 days (ASTM D 2566)



C-SYSTEMS STEEL Blue SAMPLE

PARAMETER	UNIT OF MEASURE	VALUE
Linear Shrinkage	%	0,04

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Bolt Torque test - M12 e M36 bolt with torque wrench

Bolt Torque Test M12 bolt

Bolt Torque Test M36 bolt

After torque is reached, each sample has been left in position for at least 2 minutes, at the end of the test and after disassembly of the equipment, the perforated central areas of

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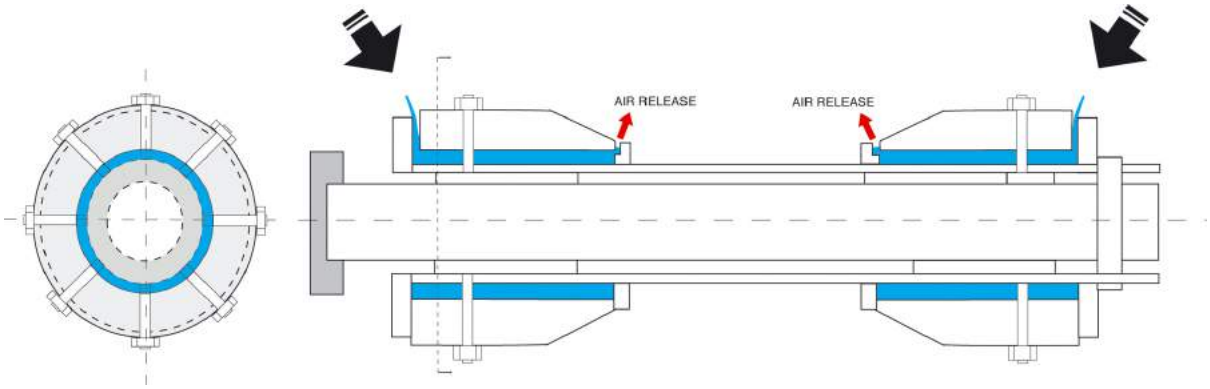
each resin sample were inspected and documented again. Any deformations and / or macroscopic lesions of the material have been observed.

Pictures of some central area after Bolt Torque test

EXAMPLES OF STRUCTURES, CROSS SECTIONS OF AREAS OF INTERVENTION



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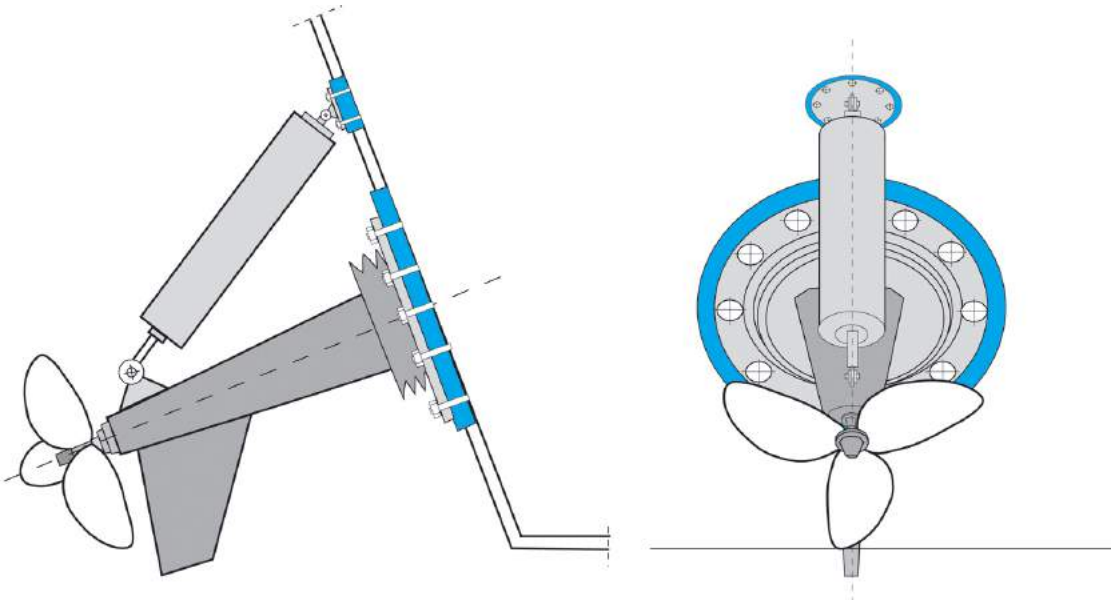
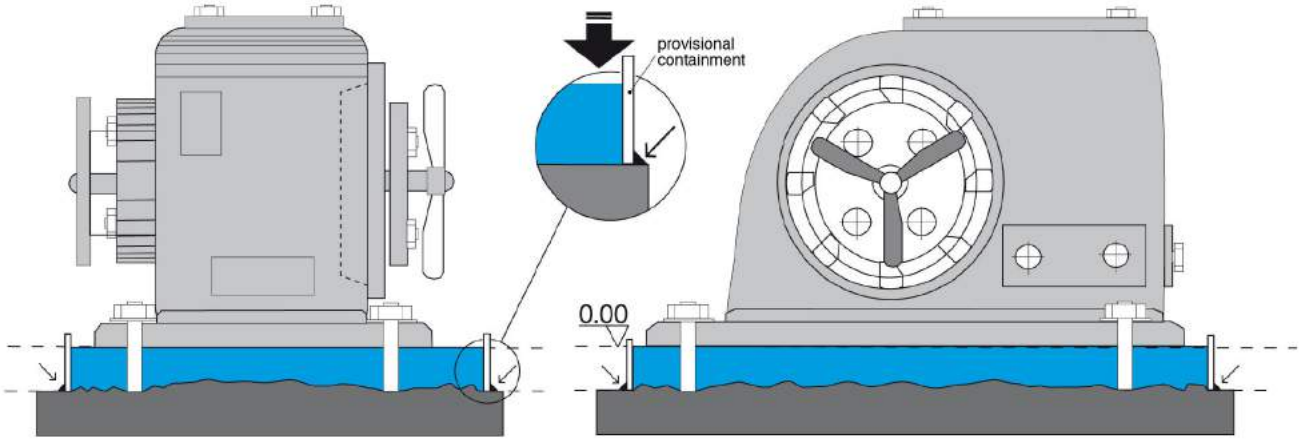
Epoxy Chocking Compound Resin





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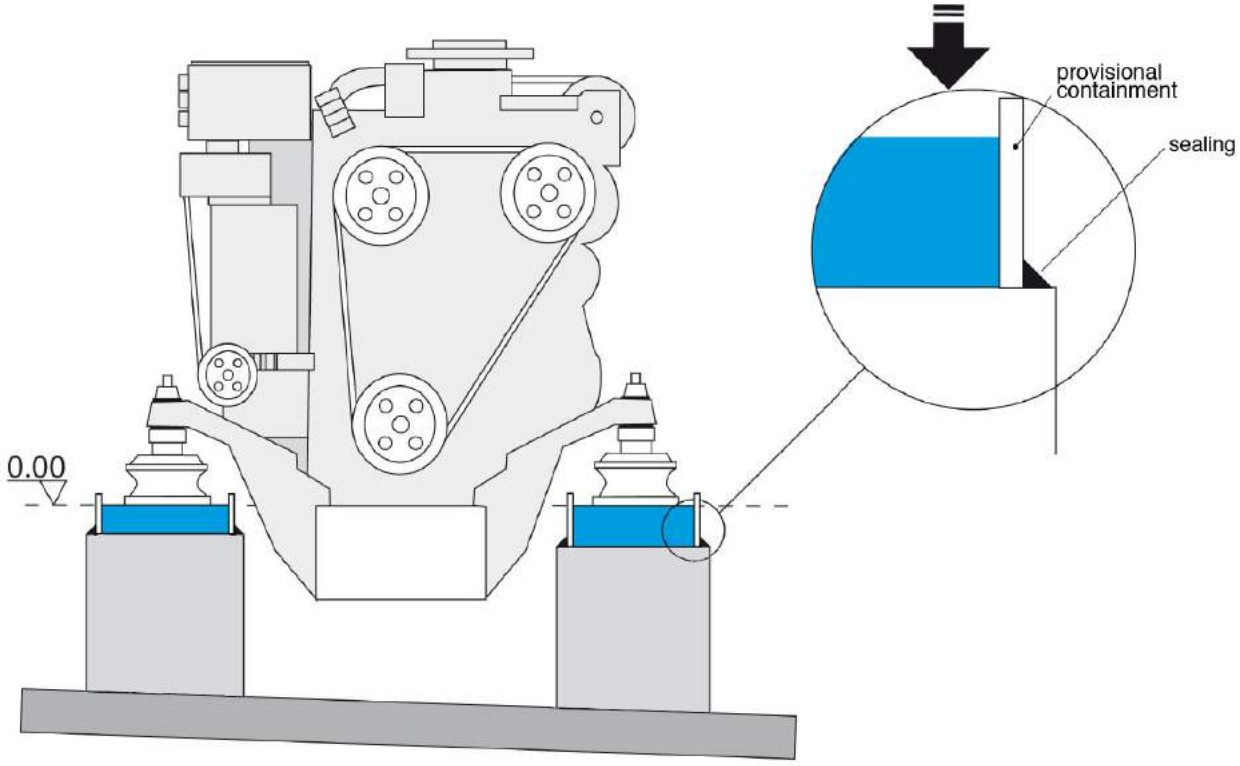
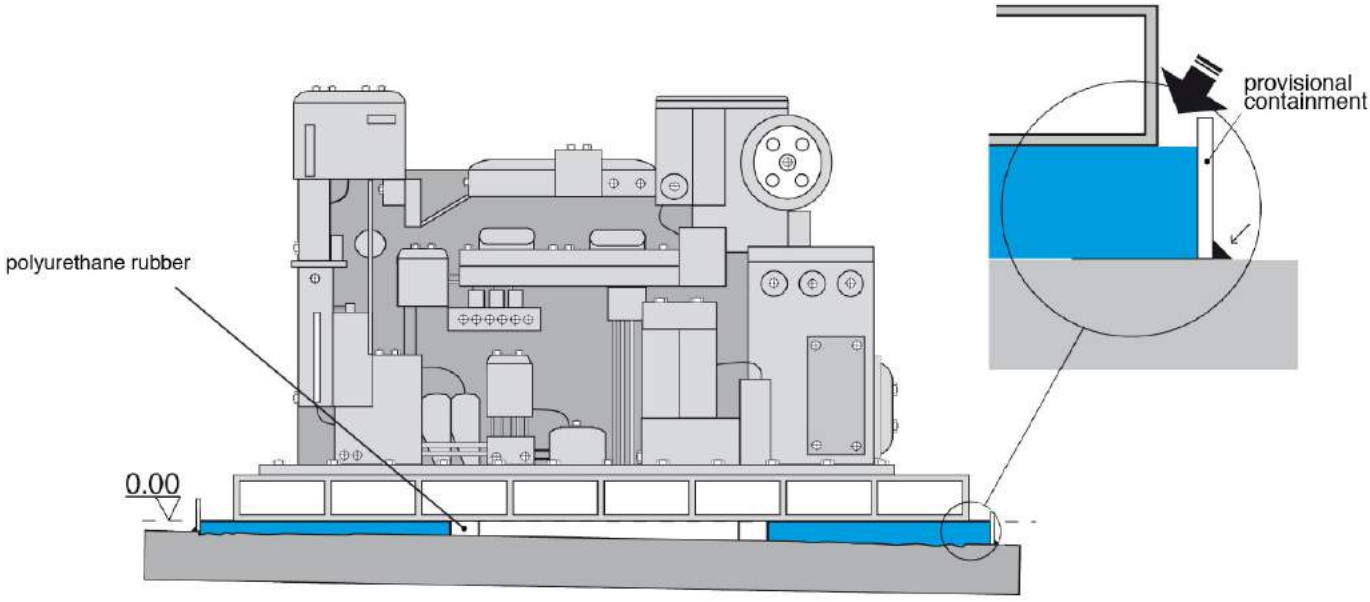
Epoxy Chocking Compound Resin





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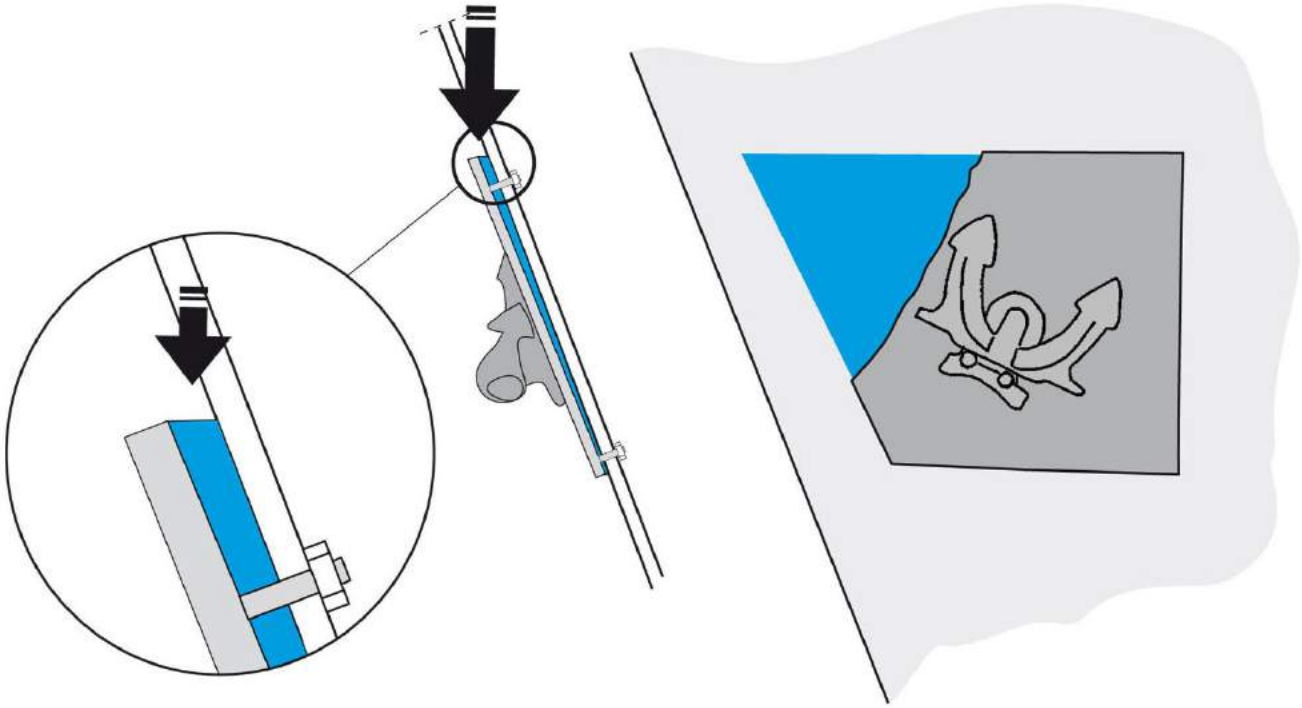
Epoxy Chocking Compound Resin



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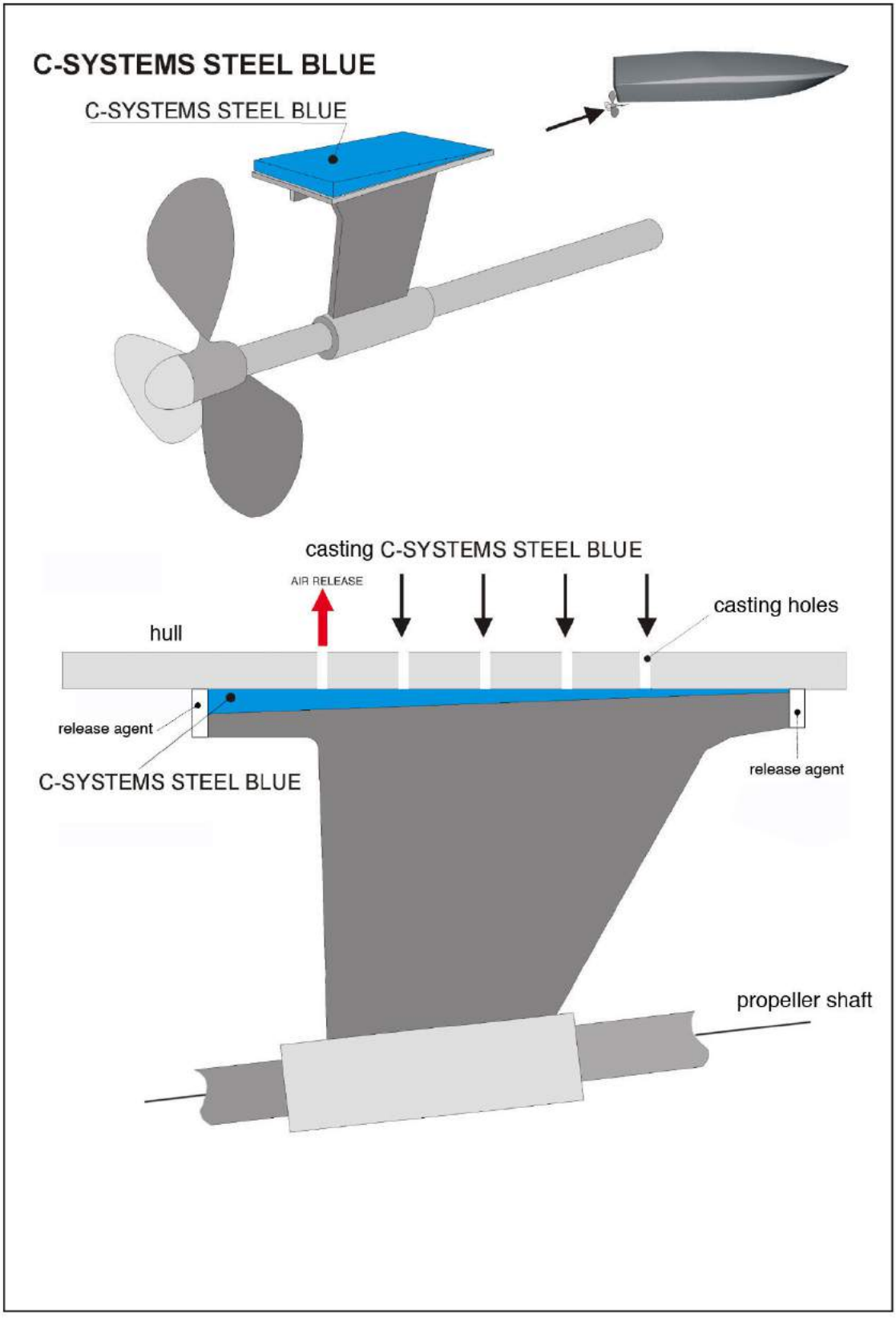

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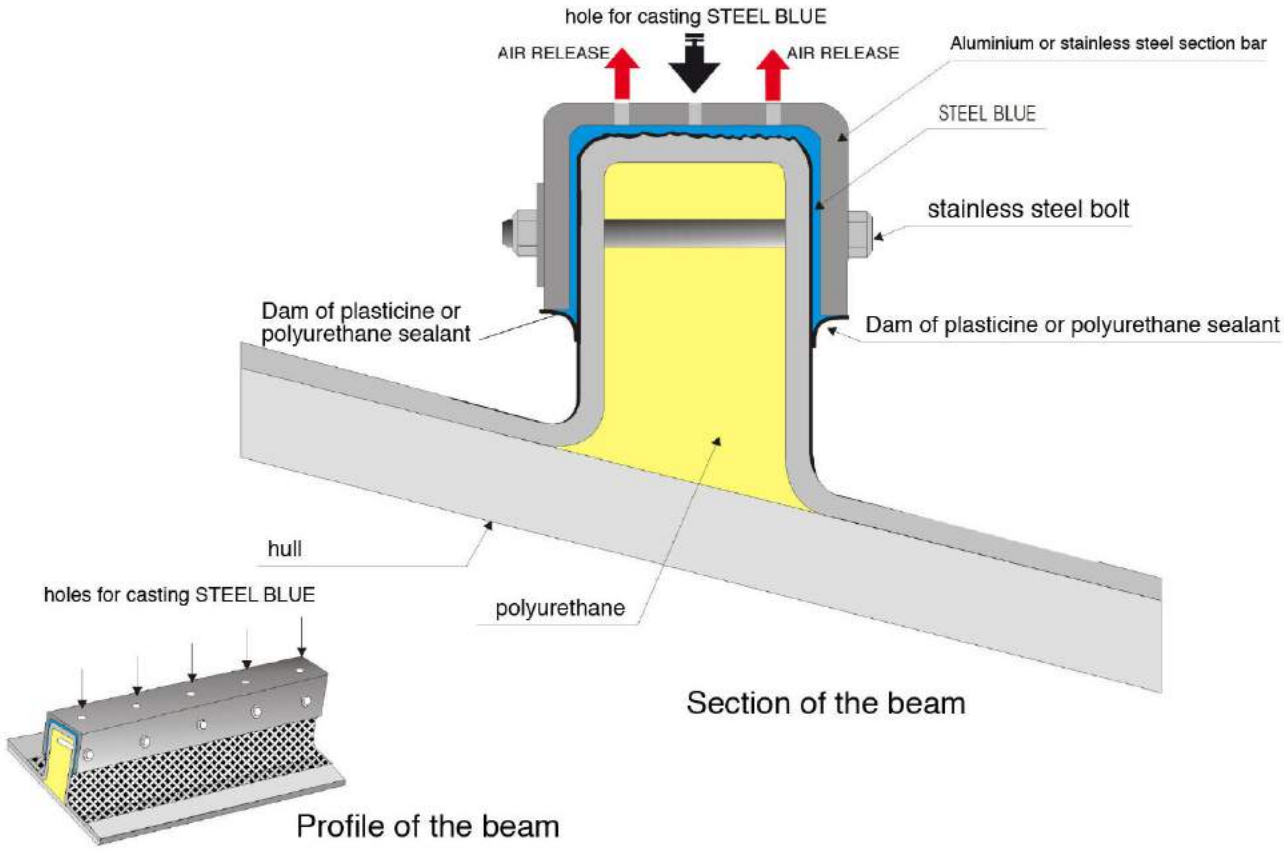
Application of Steel Blue - engines on fiberglass vessels



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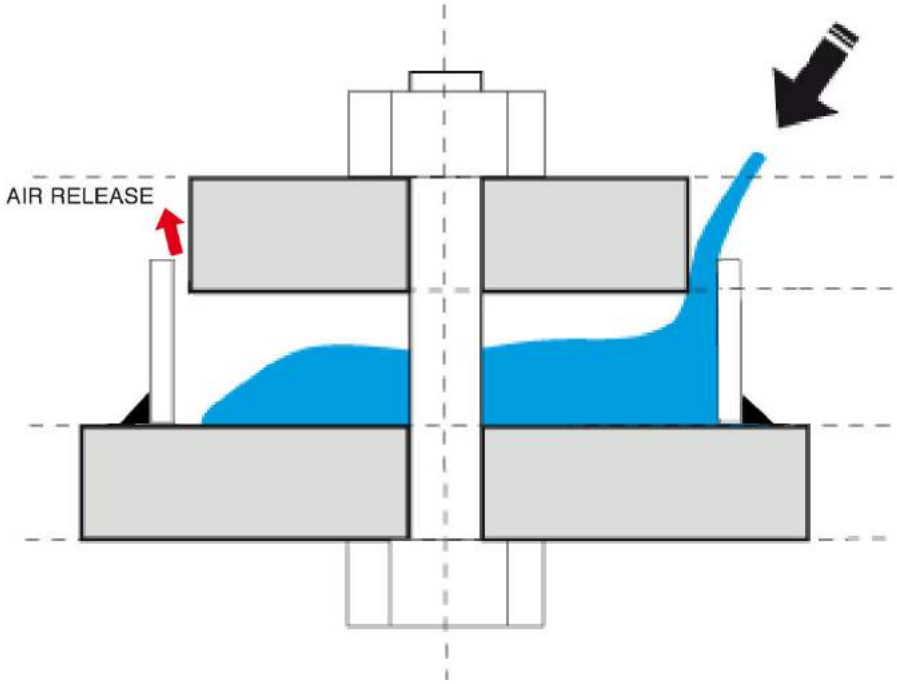
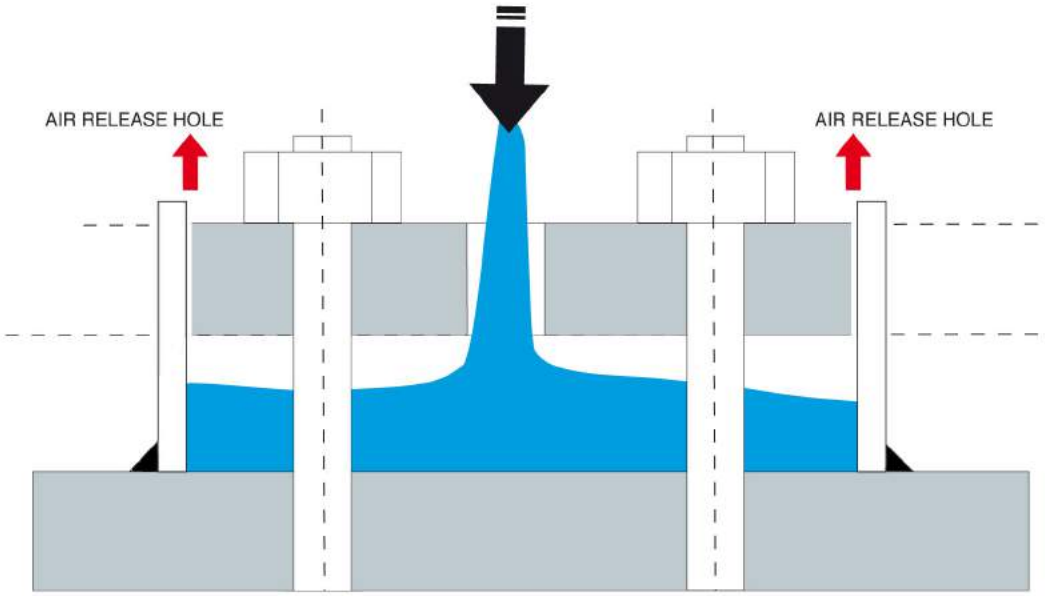
Epoxy Chocking Compound Resin





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