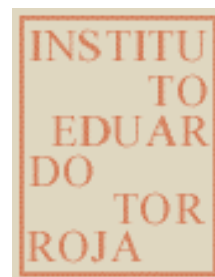


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MIEMBRO DE LA EOTA

REPORT ON THE EVALUATION OF THE TEST RESULTS

for

EUROPEAN TECHNICAL APPROVAL

Nº ETA 06/0263

on

**Liquid Applied Roof Waterproofing Kits
"IMPERMAX"**

(English language translation, the original version is in Spanish language)

1. GENERAL

The performed tests were performed on the liquid applied roof waterproofing kit, based on polyurethane "IMPERMAX", manufactured by the company KRYPTON CHEMICAL S.L.

The tests were carried out at the laboratories of the Instituto Ciencias de la Construcción Eduardo Torroja.

The assessment of the fitness for use of the liquid waterproofing kit IMPERMAX according to the Essential Requirements nº 2, 3 and 4 was carried out in compliance with "Guideline for European Technical Approval of Liquid Applied Roof Waterproofing Kits", ETAG 005, edition 2000, Part 1 "General" and Part 6 "Specific stipulations for kits based on polyurethane".

2. DESCRIPTION OF PRODUCT

The liquid waterproofing kit IMPERMAX is constituted by polyurethane resins, which once polymerised conforms elastic lining, in form of a layer completely bonded to the support (concrete, mortar, fibre-cement).

IMPERMAX kit is constituted for:

- Waterproofing liquid constituted by polyols and isocyanates, with loads and pigments mineral, and additives (anti-air entering, biocides, etc.).

The raw materials constituents of this kit are enclosed in the MTD placed in the IETcc.

3. PREPARATION OF SAMPLES

The test specimens were made according to ETAG 005 with respect to size and number.

The manufacturer performed the roof waterproofing on the substrates in presence of the testing laboratory (IETcc).

The product must be mixed with a accelerant agent (5% in weight) using an mixer of low revolutions (< 400 rpm). Once the product is mixed, it must be rested for at least 5 minutes, to avoid the presence of air burbles.

The final layer is obtained by applying two coats, the second coat was applied 24 hour after the first coat applied.

The amount of material used to performance the sample was of 2 kg/m². The layer thickness obtained was between 1,3 – 1,6 mm.

To perform specific test and verifications it was necessary to prepare free film samples of system. The most appropriated method to performance free samples, it was applying the product over a plastic sheet without creases and wrinkles.

The product was cured for 7 days (prescribed by the manufacture) at temperature of 23°C (±2) and 50%(±5) relative humidity.

The tests were carried out at curing conditions indicated above, except in those indicated cases.

This kit can be applied with a heavily protected or exposed on insulated roofs. Therefore, it is necessary to perform the tests according to two categories of maximum surface temperature of the assembled system (TH 4 and TH 2).

4. RESULTS AND ASSESMENT OF PERFORMED TEST

4.1 ER.2 Safety in case of fire

4.1.1 External fire performance

The external fire performance of the systems of mechanically fastened flexible roof waterproofing membranes was tested according to ENV 1187; and according to prEN 13501-5, is classified as B_{roof}(t1). Test report n° 06/32301345. Certification Technological Center Applus.

4.1.2 Fire reaction

The classification of this LARWK with respect to reaction fire is undertaken in accordance with prEN 13501-1 and its Euroclass is F: NPD.

4.2 ER.3 Hygiene, health and environment

4.2.1 Resistance to water vapour (EN 1931)

The value of the water vapour diffusion coefficient $\mu > 1.000$ declared by the manufacturer was confirmed.

The examination was conducted on 5 test specimens at 22°C and 90-95 % relative air humidity.

The amount of water vapour passed through the waterproof kit was:

Samples	g/(m ² /d)
1	20
2	22
3	19
4	20
5	20
Average value	20
Standard deviation	1

The value of the water vapour resistance factor obtained was $\mu = 1.485$.

4.2.2 Watertightness

The test was performed according to Technical report 003 (TR-003) "Determination of the Watertightness" of the EOTA. The examination was conducted on 3 test specimens at a hydrostatic pressure of 1 m water column during 24 hours. **The roof waterproofing remained watertight after the test.**

4.2.3 Resistance to delamination

The test was performed according to Technical report 004 (TR-004) "Determination of the resistance to delamination" of the EOTA. The examination was conducted on 5 test specimens.

SUPPORT	ADHERENCE (KPa)	
	Values	Mean value
Concrete	1.985	2.000
	1.957	
	1.992	
	2.027	
	1.894	
Ceramic	2.061	2.619
	2.834	
	3.052	
	2.969	
	2.179	
Foam polyurethane	1.985	1.491
	1.957	
	1.992	
	2.027	
	1.894	

The delamination strength of the assembled system shall exceed 50 KPa according to EOTA.

4.2.4 **Resistance to dynamic indentation**

The examination was performed in accordance with Technical report 006 (TR-006) "Determination of the resistance to dynamic indentation" on 3 test specimens each made foam polyurethane and steel (> 6mm thick) on which the roof waterproofing was applied.

The tests were carried out on specimen fully bonded to the substrate. The type of indenter I4 ($6 \pm 0,05$ mm) used did not perforate the specimens and remained watertight. The classification, according to performance level I4, in user load category is P4.

4.2.5 **Resistance to static indentation**

The examination was performed in accordance with Technical report 007 (TR-007) "Determination of the resistance to static indentation" of the EOTA on 3 test specimens each made foam polyurethane and steel (> 6mm thick) on which the roof waterproofing was applied.

The tests were carried out on specimen fully bonded to the substrate. The load applied on the specimens did not perforate the specimens and remained watertight.

Support	Load (N)	Level of resistance	User load categorisation
Steel	250	L4	P4
Foam polyurethane	200	L3	P3

4.2.6 **Resistance to fatigue movement**

The examination was performed in accordance with Technical report 008 (TR-008) "Determination of the resistance to fatigue" on 3 test specimens of fibre cement on which the roof waterproofing was applied.

The samples were kept at least 16h at -10°C before the test. The number of cycles applied was 500 (W2), after the cycles the specimens did not show cracks, loss of adhesion or split. The test was performed at -10°C temperature.

4.2.7 **Resistance to low temperatures**

The examination was performed in accordance with Technical report 006 (TR-006) "Determination of the resistance to dynamic indentation" at a temperature of $-20^{\circ} \pm 2^{\circ}\text{C}$ according to TL3 categorisation, on 3 test specimens each made foam polyurethane and steel ($> 6\text{mm}$ thick) on which the roof waterproofing was applied.

The tests were carried out on specimen fully bonded to the substrate. The type of indenter I4 ($6 \pm 0,05\text{ mm}$) used did not perforate the specimens and remained watertight. The classification, according to performance level I4, in user load category is P4.

4.2.8 **Resistance to high temperatures**

The examination was performed in accordance with Technical report 007 (TR-007) "Determination of the resistance to static" at a temperature of 90° and 60°C according to TH4 and TH2 categorisation, on 3 test specimens each made foam polyurethane and steel ($> 6\text{mm}$ thick) on which the roof waterproofing was applied.

The tests were carried out on specimen fully bonded to the substrate. The load applied on the specimens did not perforate the specimens.

Temperature 90°C

Support	Load (N)	Level of resistance	User load categorisation
Steel	150	L2	P2
Foam polyurethane	70	L1	P1

Temperature 60°C

Support	Load (N)	Level of resistance	User load categorisation
Steel	250	L4	P4
Foam polyurethane	70	L1	P1

4.2.9 **Resistance to heat ageing**

The specimens were exposed to 80°C during 100 days, according to Technical report 011 (TR-011) "Exposure procedure for accelerated ageing by heat". The period time is defined by the categorisation according to the climatic zone (severe) and the categorisation according to expected working life (W2).

Following the heat ageing period the next tests were performed:

- *Dynamic indentation (TR-006)*, the test was performed at -20°C according to the TL3 categorisation on three samples.

The tests were carried out on specimen fully bonded to the substrate (foam polyurethane and steel). The type of indenter I4 ($6 \pm 0,05\text{ mm}$) used did not perforate the specimen and remained watertight. The classification, according to performance level I4, in user load category is P4.

- *Resistance to fatigue movement (TR- 008)*, the test was performed at -10°C on 3 test specimens of fibre-cement on which the System was applied. The number of cycles was 50.

After the cycles the specimens did not show cracks, loss of adhesion, or split.

- *Tensile properties*. The test was performed in accordance with EN-ISO 527-3 on 5 samples and 5 after be exposed to heat ageing.

Samples	Tensile strength (MPa) (EN-ISO 527-3)	
	Individual values	Mean value
Heat ageing	3,2	3,3
	3,3	
	3,3	
	3,45	
	3,15	
No heat ageing	2,3	2,4
	2,5	
	2,3	
	2,3	
	2,6	
Samples	Tensile elongation (%) (EN-ISO 527-3)	
	Individual values	Mean value
Heat ageing	215	176
	162	
	170	
	152	
	180	
No heat ageing	391	361
	373	
	360	
	307	
	375	

4.2.10 Resistance UV-radiation in the presence of moisture

The specimens were exposed to UV radiation during 2000 hours, according to Technical report 010 (TR-010) "Exposure procedure for artificial weathering". This time period is defined by the categorisation according to the climatic zone (severe) and the categorisation according to expected working life (W2).

Following the UV radiation the next tests were performed:

- *Dynamic indentation (TR-006)*, the test was carried out on three specimens on the substrate (foam polyurethane and steel) at -10°C .

The type of indenter I4 ($6 \pm 0,05$ mm) used did not perforate the specimen and remain watertight. The classification, according to performance level I4, in user load category is P4.

- *Tensile properties.* The test was performed in accordance with EN-ISO 527-3 on 5 samples and 5 after be exposed to UV-radiation.

Samples	Tensile strength (MPa) (EN-ISO 527-3)	
	Individual values	Mean value
UV-radiation	2,7	3,1
	2,9	
	3,5	
	3,4	
	2,9	
No UV-radiation	2,3	2,2
	2	
	2,3	
	2,3	
	2,1	

Samples	Tensile elongation (%) (EN-ISO 527-3)	
	Individual values	Mean value
UV-radiation	197	193
	146	
	188	
	227	
	205	
No UV-radiation	391	361
	373	
	360	
	307	
	375	

4.2.11 Resistance to water ageing

The upper weathering surface of the test specimens was exposed to hot water at 60°C during 30 days, according to Technical report 012 (TR-012) "Exposure procedures for accelerate ageing by hot water". The period time of exposition is defined by the categorisation according to the expected working life (W2).

Following the hot water exposition the following tests are performed

- *Static indentation (TR-007)*, the test was performed at 90°C y a 60°C according to the TH4 and TH2 categorisation, on 3 test specimens each made foam polyurethane and steel (> 6mm thick) on which the roof waterproofing was applied,

The tests were carried out on specimen fully bonded to the substrate. The load applied on the specimens did not perforate the membrane.

Temperature 90°C

Support	Load (N)	Level of resistance	User load categorisation
Steel	70	L1	P1
Foam polyurethane	70	L1	P1

Temperature 60°C

Support	Load (N)	Level of resistance	User load categorisation
Steel	200	L3	P3
Foam polyurethane	70	L1	P1

- *Resistance to delamination (TR-004)*. The test was performed on 5 test specimens made of concrete on which the roof waterproofing was applied. The mean adhesive strength value was 3018 KPa.

Support	ADHERENCE (KPa)	
	Values	Mean value
Concrete	3.319	3.018
	2.824	
	3.037	
	2.929	
	2.984	

4.2.12 **Resistance to plant roots**

The resistance of the roof waterproofing to plant root resistance was not tested in accordance with EN 13948, therefore: NPD.

4.3 **ER.4 Safety in use**

4.3.1 **Slipperiness**

The resistance of slipperiness was not tested in accordance with SS 92 35 15, therefore: NPD.

4.4. **Related aspects of serviceability**

4.4.1 **Effect of weather conditions**

The test results determined did not indicate any significant effects on the properties of the system. The results were within the given range of tolerances when the kits were assembled and cured at 0°C and 40°C.

- *Tensile properties*. The test was performed in accordance with EN-ISO 527-3 on 5 samples.

Samples	Tensile strength (MPa) (EN-ISO 527-3)	
	Individual values	Mean value
0°C	4,5	4
	4,25	
	4	
	4,4	
	3,6	
40°C	2,8	2,7
	3,3	
	2,9	
	2,3	
	2,1	
Samples	Tensile elongation (%) (EN-ISO 527-3)	
	Individual values	Mean value
0°C	284	384
	442	
	397	
	450	
	346	
40°C	249	220
	251,5	
	226	
	200	
	175	

- *Dynamic indentation (TR-006)*, this test was performed on three samples at -10°C.

The tests were carried out on specimen on the substrate (concrete and steel). The type of indenter I4 (6 ± 0,05 mm) used did not perforate the specimen and remained watertight. The classification, following level of performance I4, in user load category is P4.

4.4.2 **Overlapping of day joints**

The delamination strength test performed on an layer assembled over other one show a good delamination strength, being upper to required value of 50 KPa.

Substrate	ADHERENCE (KPa)	
	Values	Mean value
Concrete	1.997	1.800
	1.992	
	1.665	
	1.731	
	1.531	

The table 1 shows the test results of the “IMPERMAX” kit.

4.5 Identification of components

The identification of components was performed according to ETAG 005 part. 6, section 5.8. The results comply with the specifications of the manufacturer.

4.5.1 Liquid component

4.5.1.1 *Infrared analysis.* The IR results are deposited at IETcc.

4.5.1.2 *Density.* This test was performed according to ISO 1675. The results obtained are within the given range of tolerances: $1,3 - 1,4 \text{ g/cm}^3$

4.5.1.3 *Dry extract.* The test was performed according to ISO 1768 a 105°C. The results are within the given range of tolerances: $> 82 \%$.

4.5.1.4 *Ash content.* The test was performed according to ISO 1879 at 450°C. The results are within the given range of tolerances: 29 -35 %.

4.5.1.5 *Viscosity.* The test was performed according to EN UNE- ISO 2555. The results are within the given range of tolerances: 2.000 – 4.000.

4.5.2 Accelerant agent

4.5.2.1 *Nature.* Concentrate of amines and dissolvent.

4.5.2.2 *Density.* This test was performed according to ISO 1675. The results obtained are within the given range of tolerances: $0,8 - 1 \text{ g/cm}^3$.

4.5.2.3 *Viscosity.* The test was performed according to EN UNE- ISO 2555. The results are within the given range of tolerances: $< 100 \text{ cps}$.

5. CLASSIFICATION OF THE TEST RESULTS

The results of the tests according to ETAG 005 Part 1 and Part 6 lead to the classification of the roof waterproofing "IMPERMAX" in the following performance levels:

Working life	W2 (10 years)
Climatic zone	S (Severe)
User load	P1- TH 4
	P3- TH2
Roof slope	S1 –S4
Minimum surface temperature	TL3 (- 20 °C)
Maximum surface temperature	TH4 (90°C) Exposed TH2 (60°C) Heavily protected or without isolation

Resistance to spreading fire was not tested: NPD.

Reaction to fire was not tested: Euroclass F: NPD.

Resistance to plant roots: NPD.

Slipperiness: NPD.

Table 1. Test results of the property values of the roof waterproofing "IMPERMAX"

Ref.	Properties		Particular	N° samples	Method	Results
4.1.1	External fire performance				PrEN 1187	Broof (t1)
4.1.2	Fire reaction				PrEn 13501	Category F
4.2.1	Resistance to water vapour		27 g/m ² d	5	EN 1931	$\mu = 1.485$
4.2.2	Watertightness			3	TR -003	Watertight
	Release of dangerous substances		Manufacturer declaration			Does not contain any
4.2.3	Resistance to delamination (KPa)		Ceramic	5	TR - 004	2.619
			Concrete	5		2.000
			Foam polyurethane	5		1.491
4.2.4	Resistance to dynamic indentation (23°C)		Foam polyurethane	3	TR - 006	I4
			Steel	3		I4
4.2.5	Resistance to static indentation (23°C)		Foam polyurethane	3	TR - 007	L3
			Steel	3		L4
4.2.6	Resistance to fatigue movement (-10°C, 500 ciclos, W2)			3	TR - 008	Pass
4.2.7	Resistance to low temperatures (-20°C, TL3)	P. dynamic indentation	Foam polyurethane	3	TR - 006	I4
			Steel	3		I4
4.2.8	Resistance to high temperatures (90°C, TH4)	P. static indentation	Foam polyurethane	3	TR - 007	L1
			Steel	3		L2
	Resistance to high temperatures (60°C, TH2)		Foam polyurethane	3	TR - 007	L1
			Steel	3		L4

Table 1. Test results of the property values of the roof waterproofing "IMPERMAX"

Ref.	Properties	Methods	Tests	Particular	N° Samples	Method	Results
4.2.9	Resistance to heat ageing 80°C – 100d W2	TR-011	Resistance to fatigue (-10°C, 50C)		3	TR - 008	Pass
			P. dynamic indentation (-20°C, TL3)	Foam polyurethane	3	TR - 006	I4
				Steel			I4
			Tensile strength (MPa)	Unreinforced 170x15 mm	5	EN-ISO 527-3	2,4
					5 after ageing period		3,3
			Elongation strength (%)	Unreinforced 170x15 mm	5		361
5 after ageing period	176						
4.2.10	Resistance UV-radiation in the presence of moisture 2000 h Severe climatic, W2	TR – 010	P. dynamic indentation -10°	Foam polyurethane	3	TR - 006	I4
				Steel			I4
			Tensile strength (MPa)	Unreinforced 170x15 mm	5	EN-ISO 527-3	2,2
					5 after ageing period		3,1
			Elongation strength (%)	Unreinforced 170x15 mm	5		361
					5 after ageing period		193
4.2.11	Resistance to water ageing 30d at 60°C	TR- 012	Resistance to delamination (KPa)	Concrete	5		3.018
			P. static indentation (90°C)	Foam polyurethane	3	TR -007	L1
				Steel			L1
			P. static indentation (60°C)	Foam polyurethane	3	L1	
Steel	L3						
4.2.12	Resistance to plant roots					EN 13948	NPD
4.3.1	Slipperiness					SS 92 35 15 (2)	NPD
4.4.1	Effect of weather conditions	0°C	P. dynamic indentation -10°C	Foam polyurethane	3	TR - 006	I4
				Steel			I4
			Tensile strength (MPa)	Unreinforced 170x15 mm	5	EN-ISO 527-3	4
					Elongation strength (%)		384
		40°C	P. dynamic indentation -10°C	Foam polyurethane	3	TR - 006	I4
				Steel			I4
			Tensile strength (MPa)	Unreinforced 170x15 mm	5	EN-ISO 527-3	2,7
					Elongation strength (%)		220
4.4.2	Overlapping of day joints		Resistance to delamination (KPa)		5	TR -004	1.800 Pass