

Chamber of Agriculture
North-Rhine Westphalia
Horticultural Centre Essen

Test report

**on the investigation of the root resistance of
membranes and coatings for roof planting based on
the FLL procedure (1995)**

Product name:

COSMOFIN FG

Client:

WOLFIN Bautechnik GmbH
Am Rosengarten 5
D-63607 Wächtersbach-Neudorf

Carried out by:

Chamber of Agriculture
North-Rhine Westphalia
Horticultural Training Centre Essen
Külshammerweg 18-26
45149 Essen

The report is valid for 5 years.
The report has 15 pages and
may only be used in an unabridged form.

Date of report: 01 October 2014

This report is the 2nd extension to the report of 25/09/1998

(1st extension: Report of 17/09/2009)

Information from the company Grünau Illertissen GmbH, Hanau (now: WOLFIN Bautechnik GmbH, Wächtersbach) dated 25/03/1997 on key data and material properties of the membrane tested COSMOFIN FG

Product name:	COSMOFIN FG
Application areas:	Roofing membrane; loose laying under ballast; mechanical fastening
Material base:	Plasticised polyvinyl chloride (PVC-P) with polyester fabric inlay NB
Thickness:	1.2 mm
Fittings:	Polyester fabric inlay
Form of delivery:	Rolls
Production method:	Extrusion
Material standards:	DIN 16734
Test certificates:	SKZ, FMPA, WSP
Production year:	1994

Coat/layer acting as protection against root penetration:

COSMOFIN FG membrane

Method of installation at the test site, seam spacing, overlapping:

Standard, seam spacing in accordance with FLL Guideline, 5 cm overlapping, installation of 4 PVC-P prefabricated reinforcement corners

Joining technology, joining tools, type of seam sealing:

Hot air sealing, hot air, COSMOFIN liquid as seam sealing

Addition of biocides with information on concentration:

contains no biocides

1 Preliminary remark

According to the currently valid FLL Guideline for the Planning, Execution and Maintenance of Green-Roof Sites of 2008 (FLL Guideline), the test institute may extend the validity of the test report at 5-yearly intervals. This only applies, however, if:

- ...
- the tested product still corresponds to the current delivery programme of the applicant,
- the manufacturer assures in an affirmation in lieu of oath that the membrane or coating and its production and joining technology are identical with the tested product.

This was confirmed in a letter from the companies icopal Kunststoffe Entwicklungs GmbH and WOLFEN Bautechnik GmbH, Wächtersbach on 5/6 February 2017 respectively (see Annex 1).

2 Presentation of the problem

Any protection against root penetration must permanently prevent damage to the roof waterproofing caused by invasive or penetrating parts of plants. A very high level of resistance is therefore demanded of the waterproofing and root protection membranes. The aim of this investigation was to find out whether the roof membrane "**COSMOFIN FG**", manufactured by the company WOLFEN Bautechnik GmbH, Wächtersbach, offers adequate protection against root penetration.

3 Test facility and execution

The test was conducted in accordance with the "Procedure for investigating resistance to root penetration at green-roof sites" developed by the Research Society for Landscape Development and Landscaping e.V. (FLL), 1992 edition, revised in 1995.

The test was set up on 15 September 1994 and covered a period of four years up to 9 September 1998. Eight square aluminium containers (800 x 800 x 350 mm) served as parallel test containers. The base of the containers was made of glass so that during the entire test period it was possible to check, without causing any damage, whether the roots of the plants growing in the container had penetrated through the membrane. The glass base was darkened using a lightproof foil.

On the base of the container there was a 5 cm thick moisture layer made of expanded clay 8/16 mm, which was covered with a filter fleece. The roof membrane to be tested was installed on top of this. The layer of moisture was kept permanently moist with a maximum water level of 2 cm in order to encourage the hygroscopic roots to grow downwards. A filler nozzle on the base of the container served to fill up the water supply.

The "COSMOFIN FG" roof membrane consisting of plasticised polyvinyl chloride (PVC-P) with a polyester fabric inlay is 1.2 mm thick and not bitumen compatible (see Annex 1: Key Data and Material Properties). The company Grünau Illertissen GmbH, Hanau (now WOLFIN Bautechnik GmbH, Wächtersbach) declares that the "COSMOFIN FG" roof membrane does not contain any components that are harmful to plants and that the national and regional laws in Germany on plant protection and environmental sustainability have been observed.

The membrane to be tested was installed in line with the regulations using four wall corner joints, two floor corner joints and a T-joint running in the middle up to the top rim of the container (Figure 1). The test pieces were supplied and installed in the test containers provided at the test site by the company Grünau Illertissen GmbH, Hanau (now WOLFIN Bautechnik GmbH, Wächtersbach). The membranes were joined professionally using hot air equipment. There was a 5 cm overlap. Plasticised PVC prefabricated reinforcing corners were installed in the four bottom corners and joined together with the base. All seams were then sealed using COSMOFIN liquid seam sealing.

The waterproofing in the four parallel control containers consisted of prefabricated sheets of bitumen 85/25. The sheets measured 790 x 790 mm and were 20 mm thick. The seams between the bitumen sheets and container wall, measuring 5 mm wide and 20 mm deep, were sealed with a plant and material-compatible waterproof joint sealing compound. Installation was carried out by a specialist roofing contractor at the test institute.

The vegetation layer consisted of a growth medium of 70 % slightly decomposed North German raised bog peat and 30 % expanded shale, broken 8/16 mm. The growth medium was firmly compacted on top of each membrane with a thickness of approx. 25 cm so that there was a 5 cm deep rim for watering. The nutrients and ph-value were set

in the manufacturing plant of the supplier on the basis of a fertiliser analysis in line with the specifications in the FLL Guideline.

Two grey alders (*Ainus incana*) biennial transplanted seedlings 60/100, and two aspens (*Populus tremula*) biennial transplanted seedlings 50/80 were sown in each container and 2.5 g/m² of couch grass (*Agropyron repens*) sown. Figure 2 shows the arrangement of the test plants. During the years 1995/96 individual woody plants were regularly planted to replace dead plants.

The plants were top watered onto the growth medium during the growing period and later using a standpipe which stood on a square base immediately above the membrane with slits to allow water to pass. In order to ensure that the plants grew during the entire test period, each year in spring 50g Nitrophoska perfekt (15-5-20) was added to each container as a fertiliser.

Every year at the end of May/beginning of June and at the end of the vegetation period in October, visual inspections were carried out through the transparent base in order to see whether root penetration had occurred. At the end of the test (9 September 1998), the containers were emptied and a more detailed inspection of the membrane to be tested was carried out. The number and also the position of any roots that had penetrated into or through the membrane were recorded.

In addition, during the entire test period and at the end of the test, the growth rates of the plants in the test and control containers were determined by measuring the height of the plant and the diameter of the trunk at a height of 10 cm.

4 Information from the manufacturer on the membrane tested

The investigation of root resistance is linked to the key data and material properties of the membrane tested and the joining and production methods used. The relevant information from the manufacturer of the membrane to be tested COSMOFIN FG is provided on page 2 of the report.

5 Results

Visual inspections of the waterproofing system to be tested through the transparent container base revealed no root penetration during the entire period of the test (see Table 1).

A closer examination of the eight test containers after the end of the test confirmed the statement above.

No root invasion or penetration could be established in any of the eight test containers. (Table 2).

In the control containers where bitumen 85/25 was used as a sealing material, root penetration was already established in all four control containers after the first year (inspection on 11 September 1995) during a visual inspection (Table 1). When the containers were opened on 9 September 1998, all four containers show intensive root penetration and a lot of root invasion in the 2 cm thick bitumen sheet (Table 2).

The growth performance data (trunk diameter, plant height) showed that both the aspen as well as the grey alder had grown very vigorously at the beginning of the test. The annual growth diminished as the test progressed. As a result of the strong growth, less light was available and consequently the annual growth diminished. This was particularly visible in the aspen and the couch grass. (Tables 3 - 7). Overall, growth can be described as good so that we can assume a sufficiently high pressure from the roots.

4. Summary

"COSMOFIN FG" roof membrane made of plasticised polyvinyl chloride (PVC-P) with a polyester fabric inlay NB was tested from September 1994 to September 1998 at the Training and Testing Institute for Horticulture, Agriculture and Cemetery Nurseries Essen run by the Chamber of Agriculture of the Rhineland (now: Horticultural Training Centre Essen of the Chamber of Agriculture North-Rhine Westphalia) using the "Procedure for investigating resistance to root penetration at green-roof sites" developed by the Research Society for Landscape Development and Landscaping e.V.

No root penetration could be established in the final evaluation.

According to this examination, the membranes used can be assessed as root-resistant in accordance with the FLL Guideline.

The results of the tests are linked to the key data and material properties of the membrane/layer (cf. Annex 1) listed in the test report in accordance with the requirements in Section 3 "Requirements" of the FLL Guideline (1992 edition, revised in 1995) and may not be transferred to other products.

The report may only be used in an unabridged form. No interim results may be published.

Reserve samples of the membrane tested are stored in the Horticultural Training Centre Essen.

The report has 15 pages.

Report by: Dipl. Ing. agr. Martin Monreal

Essen, 22 February 2017

[signed]

Dr K.H. Kerstjens

Director Horticultural Training Centre Essen

[Round stamp of North-Rhine
Westphalia Chamber of Agriculture -
Horticultural Training Centre Essen]

Table 1: Root penetration during the course of the test - recorded through visual checks of the base of the test containers

Roof membrane:	Number of containers with root penetration on:			
	11/09/1995	12/01/1996	05/03/1997	15/04/1998
COSMOFIN FG (8 containers)	0	0	0	0
Bitumen sealing - Control (4 containers)	4	4	4	4

Table 2: Frequency of root invasion and penetration at the end of the test on 9 September 1998 in 8 containers sealed with COSMOFIN FG - roof membrane and 4 control containers with bitumen sealing

a) COSMOFIN FG

Container No.	Number of root invasions								Number of root penetrations							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
on the surface	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
in corners without joints	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
in the longitudinal seams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
in the corner seams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
in the T-seams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

b) Bitumen sealing (control)

	> 100	--	--	--	--	45	50	60	56	--	--	--	--
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Table 3: Trunk diameter and height of grey alder and aspen in containers with bitumen sealing
(Interim evaluation of 01/03/1996; 12/02/1997; 08/04/1998)

a) Grey alder (*Ainus incana*)

Container No.	Tree No.	Plant height (cm)*			Trunk diameter (mm)**		
		1996	1997	1998	1996	1997	1998
C1	1	2.20	360	380	20.0	28.5	31.3
	2	2.40	350	370	18.0	26.1	30
C2	1	2.50	300	320	19.0	30	32
	2	1.80	360	340	14.0	25.4	30.6
C3	1	2.42	360	380	24.0	25	32.4
	2	1.22	350	370	12.0	24.2	30.9
C4	1	2.56	320	370	23.0	28	35.7
	2	2.43	260	250	16.0	16.7	18.8

b) Aspen (*Populus tremula*)

Container No.	Tree No.	Plant height (cm)*			Trunk diameter (mm)**		
		1996	1997	1998	1996	1997	1998
C1	1	160	225	250	12.0	12	12.3
	2	155	145	140	15.0	11.3	11.6
C2	1	150	120	120	12.0	12.8	12.4
	2	215	200	230	15.0	16	17.2
C3	1	228	220	230	14.0	14.1	14.4
	2	189	235	270	11.0	15	16.9
C4	1	161	200	260	13.0	13.6	12.7
	2	165	205	270	14.0	15.6	18.4

*) measured from the substrate to the highest tip of the shoots

***) measured 10 cm above the substrate

Table 4: Trunk diameter and height of **grey alder** in containers with COSMOFIN FG as roof waterproofing membrane
(Interim evaluation of 01/03/1996; 12/02/1997; 08/04/1998)

Container No.	Tree No.	Trunk diameter in mm *			Plant height in cm **		
		1996	1997	1998	1996	1997	1998
1	1	21	28.3	33	250	300	320
	2	20	25.9	35.5	220	315	340
2	1	19	25.4	30.8	160	230	380
	2	27	30.8	40	125	260	370
3	1	22	28.5	32.6	260	360	360
	2	22	26	27.6	260	340	360
4	1	20	25.3	29	275	360	350
	2	21	27	28.9	230	340	340
5	1	22	25.4	30.9	252	320	350
	2	23	27.7	31.9	285	340	360
6	1	21	24.5	35	276	300	370
	2	18	26	31.6	271	310	360
7	1	24	28.5	32.4	239	289	310
	2	19	27	31.7	261	300	330
8	1	25	27.5	30.1	255	350	400
	2	24	34	41.3	310	360	440

*) measured 10 cm above the substrate

***) measured from the substrate to the highest tip of the shoots

Table 5: Trunk diameter and height of **aspen** in containers with COSMOFIN FG roof waterproofing membrane
(Interim evaluation of 01/03/1996; 12/02/1997; 08/04/1998)

Container No.	Tree No.	Trunk diameter in mm *			Plant height in cm **		
		1996	1997	1998	1996	1997	1998
1	1	12	13	13.6	110	105	110
	2	10	10.8	...	125	155	...
2	1	12	13.7	13.6	140	195	250
	2	12	13	12.9	140	110	110
3	1	11	11.7	12.3	125	140	170
	2	10	12.3	13.2	140	200	220
4	1	11	11.2	11.8	130	140	140
	2	11	13	13.3	205	280	300
5	1	11	11	12.2	144	170	240
	2	11	12	13.2	141	160	200
6	1	11	11.5	12.9	155	160	190
	2	14	14.2	14.8	131	140	150
7	1	13	13.5	14.7	149	160	210
	2	13	13.2	13.6	206	215	230
8	1	14	16.5	...	97	150	...
	2	14	14.3	14.6	186	200	220

*) measured 10 cm above the substrate

**) measured from the substrate to the highest tip of the shoots

Table 6: Trunk diameter and height of woody plants in containers with COSMOFIN FG
- Evaluation at end of test on 9 September 1998

Container No.	Tree No.	Grey alder (<i>Ainus incana</i>)		Aspen (<i>Populus tremula</i>)	
		Diameter* mm	Height ** cm	Diameter* mm	Height ** cm
1	1	36	312	13	138
	2	31	320	10	150
2	1	33	380	13	295
	2	43	345	12	100
3	1	34	345	11	175
	2	28	340	12.5	225
4	1	31	390	11.5	145
	2	31	337	13	300
5	1	32	337	12	298
	2	32	328	12.5	224
6	1	37.5	328	12.5	192
	2	32.5	405	12.4	146
7	1	39	370	15	230
	2	32	328	14	255
8	1	28	400
	2	41	490	15	260

Table 7: Trunk diameter and height of woody plants in containers with bitumen sealing (control containers)
- Evaluation at end of test on 9 September 1998

Container No.	Woody plant No	Grey alder (<i>Ainus incana</i>)		Aspen (<i>Populus tremula</i>)	
		Diameter* mm	Height ** cm	Diameter* mm	Height ** cm
1	1	32.5	390	11.5	250
	2	33	370	10.5	150
2	1	37	290
	2	30	300	18	270
3	1	34	400	14	220
	2	35	390	16	320
4	1	39	470	15	280
	2	16	290	20	310

*) measured 10 cm above the substrate

**) measured from the substrate to the highest tip of the shoots

[For figure see attached German document]

Figure 1: Arrangement of joints in isomeric container view

[For figure see attached German document]

E: Grey alder
Z: Aspen
Q: couch grass

Figure 2: Arrangement of plants in test container

**Annex 1: Declaration of WOLFIN Bautechnik GmbH and Icopal Kunststoffe
Entwicklungs GmbH on 6/5 February 2017 respectively**

**WÖLFIN®
Bautechnik**

WÖLFIN Bautechnik GmbH - Am Rosengarten 5 - D-63607 Wächtersbach

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Date	Contact	E-Mail	Tel./Direct dial
06/02/2017	Cécile Hahn	Cecile.hahn@wolfin.com	+49 6053 708-5159

Confirmation recipe COSMOFIN FG

Dear Mr Monreal,

Please find enclosed the confirmation concerning the recipe for the COSMOFIN FG membrane for the extension of the FLL test report.

Yours truly,
[signed]
Cécile Hahn
Export Sales Manager

Bank account
Nordea Bank Finland Plc
(Frankfurt am Main branch)
Acc. 6526280001
Code 51430300

BIC/SWIFT NDEADEF
IBAN DE75514303006526280001
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Registered office of company
Wächtersbach
Commercial Register
Hanau Local Court
HRB 93718

Managing directors
Günther Reese
Mathew Scofield

Test Institute: North-Rhine Westphalia Chamber of Agriculture - Horticultural Training Centre Essen

Client: WOLFIN Bautechnik GmbH, 63607 Wächtersbach-Neudorf

Product tested: Cosmofin FG

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Icopal Kunststoffe [logo]
Entwicklungs
GmbH

Chamber of Agriculture
North-Rhine Westphalia
Horticultural Training Centre Essen
Attn. Mr Monreal
Külshammerweg 18-26
D-45149 Essen

Confirmation

0502/2017

Dear Mr Monreal,

We herewith confirm that both the recipe and the structure of the non-bitumen-tolerant roof membrane Cosmofin® FG are identical to the membrane which you tested for root resistance.

Yours faithfully,

[signed]

Dr. Udo Simonis

Icopal Kunststoffe Entwicklungs GmbH
Head of R&D Synthetics

[Company stamp]

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VR Main Kinzig eG: Sort code: 506 616 39 Account No.: 7469683
Managing directors: Dr. Udo Simonis, Robert Germar
Commercial Register: Hanau Local Court HRB 13088
Tax No. 4423985523
VAT ID. DE 813417384

Translator's comments in [...]

I hereby certify that the above translation concords fully with the document submitted to me.

Obertshausen, 17 October 2017

Joanna Massmann, duly authorised translator for the courts and
Hessen.

