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Evaluation of EasyFloat® pier elements

Commission

Test of EasyFloat® pier elements with respect to corrosion, weathering, impact, staining, fire, abrasion and water absorption. A study of the environmental impact of the different materials during use was also carried out.

Test items

Two floating elements consisting of polystyrene foam contained in a polyethylene (PE) casing. One side bar assembled in one corner piece, parts made of anodized aluminium, plastic (PP) cover and stainless steel fasteners. See Appendix 2 for more details on the tested product.

Summary of results

For details of the results, see under "Results" later in this report. A summary is given in the table below.

Test	*Method*	*Summary of results*
Corrosion resistance	ISO 9227	Good corrosion resistance
Weathering	ISO 4892-2	No visual changes
Impact test	EN 397	No cracking, some deformation, impact resistance unchanged after weathering exposure
Staining	NICE	No visual changes
Reaction to Fire	EN ISO 11925-2	No ignition on surface exposure
Abrasion	ISO 11998*	No visual changes
Water absorption	IEC 68-2-30	No absorption
Environmental impact during use	-	No or negligible impact

*) modified

Test methods in some detail

Corrosion resistance

The test is neutral salt spray according to ISO 9227 for 10 days (240 hours). This test corresponds to ASTM B 117. The test was carried out on the corner piece attached to about 10 cm of the side bar. Test conditions:

Temperature	35 ± 2°C
pH in collected solution	6.5 – 7.2
Volume of collected solution	1 - 2ml / 80 cm^2, hour
Concentration of collected solution	5.0 ± 0.5 % NaCl (70.2 – 84.0 mS/cm)

The sodium chloride used for the salt solution contained less than 0.001 % copper respective nickel and less than 0.1 % sodium iodide. The exposure was carried out January 4 – 14, 2008.

The test is severe; the mass loss of steel in this test is approximately 35 g/m^2 during 24 hours (for reference, see the standard ISO 9227). For zinc, which builds up the protective coating on galvanized steel, the loss of material is about 40 micrometer in 10 days, which is a lot considering that a good galvanizing can imply a zinc layer of about 50 micrometer. This is due to the high salinity and that the surface is never allowed to dry up which means that the protective zinc oxides cannot form. In an out-door environment there are normally dry periods.

Weathering resistance

Three panels, cut out from the top of the polyethylene casing, were exposed for 2000 hours according to ISO 4892-2 in an *Atlas Weather-Ometer Ci 4000*. The light source was a 6.5 kW water cooled xenon lamp. The lamp was equipped with an inner filter and an outer filter, both of borosilicate glass. With this filter system a spectral power distribution with a lower limit of 290 nm is obtained. The inner filter is replaced each 400 hours and the outer filter is replaced each 2000 hours. The light intensity was 60 ± 6 W/m^2 within the band pass 280-400 nm, 550 ± 55 W/m^2 within the band pass 280-800 nm. This light closely resemble natural sunlight. The temperature on a black standard thermometer was 65 ± 3 °C, the air temperature 38 ± 3 °C and the relative humidity 50 ± 5 %. A spray cycle of 102/18 minutes with deionised water was used (102 min dry interval, 18 min of spraying). The samples were inspected by comparing with unexposed material every 500 hours in a D65 light cabinet. If only the light dose is considered 2000 h in this exposure corresponds to 2.5 years in Lochem, Holland; 1.7 years in Sanary, southern France and 1.6 years in Singapore. There are, however, other factors that influence the acceleration factor, like temperature and humidity. The fact that a product might not be exposed to direct sunlight all day due to shading or not facing south, should also be taken into account.

Impact resistance

The impact test procedure was taken from SS-EN 397 *Industrial safety helmets*, clause 5.1.1 *Shock absorption*. However, instead of a head form, a flat steel anvil was used for placing the test samples on. Also no impact force was measured. The fall weight was a 5 kg spherical steel striker with 50 mm radius. The fall height was 1 m. The test was performed in room temperature.

A penetration test was performed on two of the samples, one aged and one unconditioned. The test was performed according to SS-EN 397, clause 5.1.2 *Resistance to penetration*. A 3 kg striker with 60º point angle was dropped from 1 m on to the sample. The plastic sheets had previously been impact tested but a new EPS slab was used for each test.

Pictures of the strikers are shown in Appendix 1.

Stain resistance

The method used was developed in a NICe project and is meant to determine the sensitivity to accidental staining (on floors). In brief the staining fluid is applied by dropping it on the surface, the sample is then left for 24 hours. After that the panels are washed using an equipment according to ISO 11998 or ASTM D 2486 and the panels are examined visually. The test was carried out on pieces of the top side of the element casing.

Reaction to fire (ignitability)

The test was carried out according to EN-ISO 11925-2 on the top side of one element. The samples were conditioned prior to the test according to EN 13238, 2001: temperature (23 ± 2) °C, relative humidity (50 ± 5) %.

Abrasion

An equipment according to ISO 11998 or ASTM D 2486 was used, equipped with a (type ScotchBrite™) rubbing cloth. The test was performed under dry conditions on both the top PE material and the aluminium bar.

Water absorption

A piece of the construction was tested in a cyclic climate test in order to study the amount of water that is absorbed through the ventilation holes on the side of the floating element. An element was cut about five cm from the edge and the smaller end was used in the test in order to facilitate exposure and gravimetric evaluation. The test piece was thoroughly sealed in the cut end, weighed and exposed according to IEC 68-2-30 where the temperature is kept at 55°C for 12 hours and thereafter at 23ºC for 12 hours at high relative humidity (over 95%). The sample was exposed for 10 days (10 cycles). The sample was weighed before and after the exposure.

Results

Corrosion resistance

No defects on the anodised aluminium part except from a slight discolouring near the bolts. No impact on parts made of stainless steel could be seen. The bolts showed no change either. One bolt was loosened and the area beneath it was inspected, there were no defects on the anodised aluminium there. The overall conclusion from this test is that the corrosive exposure had a negligible impact on the product.

Weathering resistance

After the exposure the test pieces showed no change in appearance; colour and gloss etc were unchanged. The samples were then submitted to impact test, see below.

Normally gloss and colour changes occur gradually. It is, therefore, likely that no or slight changes would occur after some few thousands hours more exposure than 2000 hours. Considering the acceleration performance of this test and the test result we consider it very unlikely that weathering will have any significant effect on this material during 10 years of use in Europe.

Impact resistance

Six samples were impact tested, three aged (exposed 2000 h in accelerated weathering) and three unconditioned. The samples (plastic sheets) were placed on a 40 mm thick EPS slab after which the striker was allowed to fall on the centre point of the sample. See results in the table below.

Sample no.	*Conditioning*	*Result*
1	Aged	Permanent deformation on plastic sheet and EPS. No cracks.
2	Aged	Permanent deformation on plastic sheet and EPS. No cracks.
3	Aged	Permanent deformation on plastic sheet and EPS. No cracks.
4	None (ambient)	Permanent deformation on plastic sheet and EPS. No cracks.
5	None (ambient)	Permanent deformation on plastic sheet and EPS. No cracks.
6	None (ambient)	Permanent deformation on plastic sheet and EPS. No cracks.

For the penetration test the striker penetrated the plastic sheet in both tests but did not penetrate the 40 mm thick EPS.

See pictures in Appendix 1.

Stain resistance

A text-based scale of grades was used when evaluating the remaining stains after the washing procedure. The test specimens were assessed by ocular inspection. The grades are:
0 – Unchanged, i.e. no perceptible change
1 – Very slight, i.e. just perceptible change
2 – Slight, i.e. clearly perceptible change
3 – Moderate, i.e. very clearly perceptible change
4 – Considerable, i.e. pronounced change
5 – Severe, i.e. intense change

Results:

Staining agent	***Grade***
Red wine	0
Coffee	0
Petrol	0
Motor oil	0

This means that the tested material is resistant to staining of the listed agents.

Reaction to Fire

According to EN 13501-1 products are tested with surface flame attack only if in the envisaged end use application direct flame attack on the edge cannot occur.

Results for surface flame attack are shown below. Flame exposure time was 30 seconds.

Test no	1	2	3	4	5	6
The sample ignited, s	NI	NI	NI	NI	NI	NI
The flames reach 150 mm, s	-	-	-	-	-	-
Burning droplets	No	No	No	No	No	No
Time when filter paper ignited, s	-	-	-	-	-	-

NI = No ignition

The criteria according to "Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests", EN ISO 13501-1, February 2002 are:

To meet class E construction products excluding floorings and linear pipe thermal insulation products have to meet the following limits when tested according to EN ISO 11925-2:

- Flame tip must not reach 150 mm vertically from the point of application of the test flame, within 20 s from the time of application. 15 s exposure time. Ignition of the filter paper (d2 classification).

Abrasion

Both the aluminium bar and the top material were subjected to 2000 cycles, a cycle being one 30 cm stroke in either direction. No visible changes could be detected on any of the test pieces after exposure.

Water absorption

The sample did not gain weight during the exposure.

Environmental impact during use

A pier element consists of a central floating cell, 60 x 120 cm, of polystyrene foam contained in a polyethylene casing. The floating cells are mounted side by side and contained in a frame made of anodized aluminium (AW-6060-T6) bars fastened in the corners by stainless steel (SS 2343 / AISI 316) bolts and angle irons. The corners are covered with polypropylene plastic covers. Approximate amounts of materials for one standard product 1.2 x 3 meters consisting of five elements are:

Polyethylene: 24.5 kg
Polystyrene: 14.5 kg
Polypropylene: 1.0 kg
Aluminium: 25.6 kg
Stainless steel AISI 316: 1.8 kg

The analysis below assumes a lifetime of 10 – 20 years and that all material is recycled or recovered properly after the service life-time of the product. The analysis is restricted to the in use period, the environmental impact of manufacturing of the components has not been considered.

Polyethylene (PE)
The polyethylene used is of high density type. The material was visually unaffected by the 2000 hours of exposure in artificial sunlight. It is likely that loss of material due to degradation at the surface of the pier elements is negligible during the lifetime of the product. Furthermore the material is non-toxic. Therefore the PE has no or negligible impact on the environment (see reference [1]).

Polystyrene
The polystyrene is contained in the casing during the entire lifetime of the product. Therefore, no littering or loss of material by mechanical damage is expected. The only possible contamination path is through the few small ventilation holes on the sides of the casing, either by leaching by see water or by evaporation. Considering the unlikely situation of any significant flow of leaching water, the harmless material and the casing the conclusion is that the material has no or negligible impact on the environment (see reference [1]).

Polypropylene
The amount of propylene used is quite small, only about one kilogram for a 3 x 1.2 meter pier element. This material is, like PE, harmless to the environment if the littering aspect is neglected. The polypropylene has no or negligible impact on the environment during the lifetime of the product (see reference [1]).

Anodized aluminium
Loss of material in this case can only be caused by corrosion provided that the product does not fall apart. If a very corrosive environment like a marine environment is considered, the corrosion rate for this type of aluminium is still very low. The anodizing increases the corrosion resistance and makes the product even more durable. The aluminium bar is not immersed in the water when there is no load on the pier, so long dry periods can be expected, making the environment less harsh. The only cause of corrosion of any significance could be by means of galvanic corrosion where the bars are fastened by the stainless steel bolts. However, experience with boats, canoes etc, where aluminium is fastened by AISI 316 bolts shows that this is not really a problem. Aluminium is a very common element in the nature. Under normal pH the aluminium present in the nature is bound in less accessible compounds and minerals and thus harmless. The conclusion is that the aluminium bars has no or negligible impact on the environment during the lifetime of the product (see reference [2]).

Stainless steel
The stainless steel used, AISI 316 or SS 2343, contains approximately 17% chromium, 12% nickel, 2% manganese, 2% molybdenum and some other elements in smaller amounts. The corrosion rate in a normal outdoor environment is negligible. The amount used for the exemplified pier element is less than two kilos. Thus the conclusion is that the stainless steel has no or negligible impact on the environment during the lifetime of the product (see reference [2]).

The overall conclusion is that the evaluated product EasyFloat® pier elements has no or negligible impact on the environment during its service lifetime.

Conclusions

The test results indicate that the product is corrosion resistant, resistant to weathering and sunlight, resistant to staining by common normally aggressive staining agents, resistant to impact and resistant to abrasion. Ignition on the upper surface does not easily occur. The pier element has no or negligible impact on the environment during its service lifetime.

References

[1] Brydson, J. A., “Plastic Materials”, fifth edition, Butterworths, 1988.
[2] ASM Handbook, Volume 13B, Corrosion: Materials, 2005

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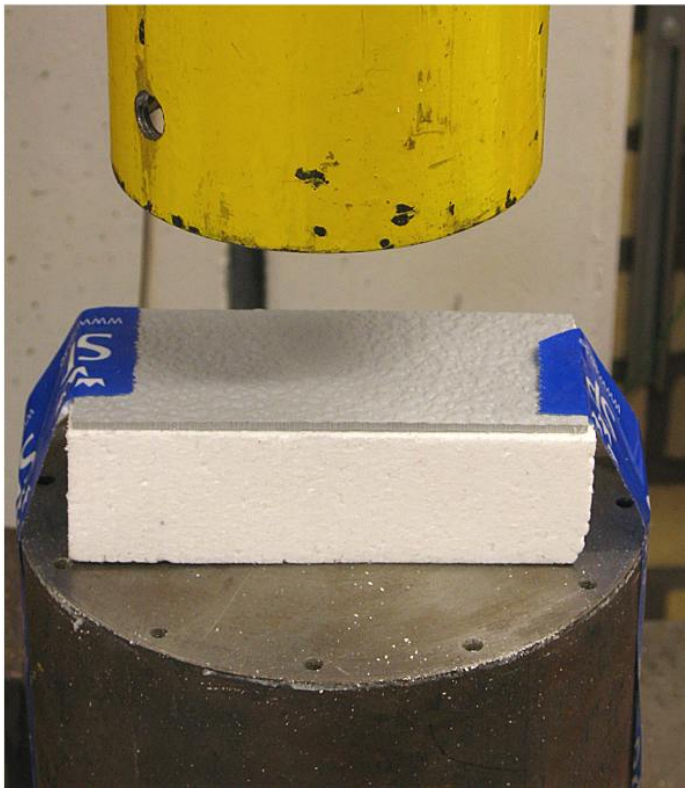
Appendix
Appendix 1: showing pictures from the impact test
Appendix 2: details of the tested product

Appendix 1

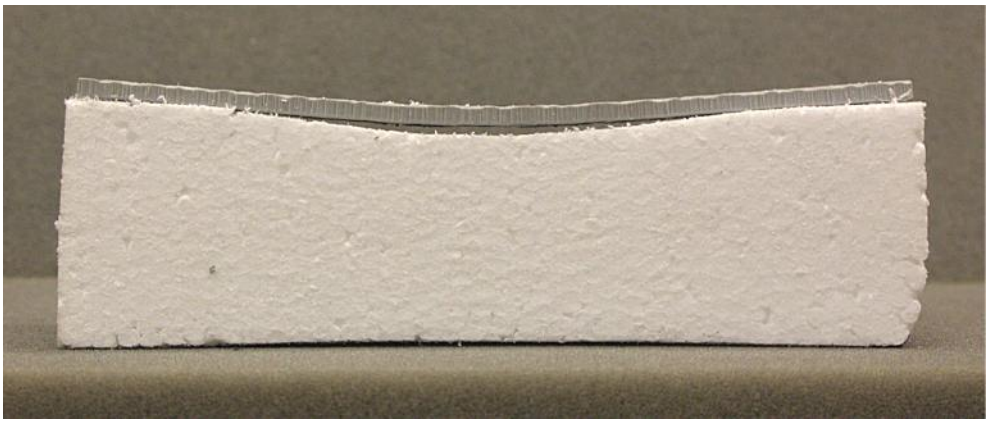
Pictures from the impact test

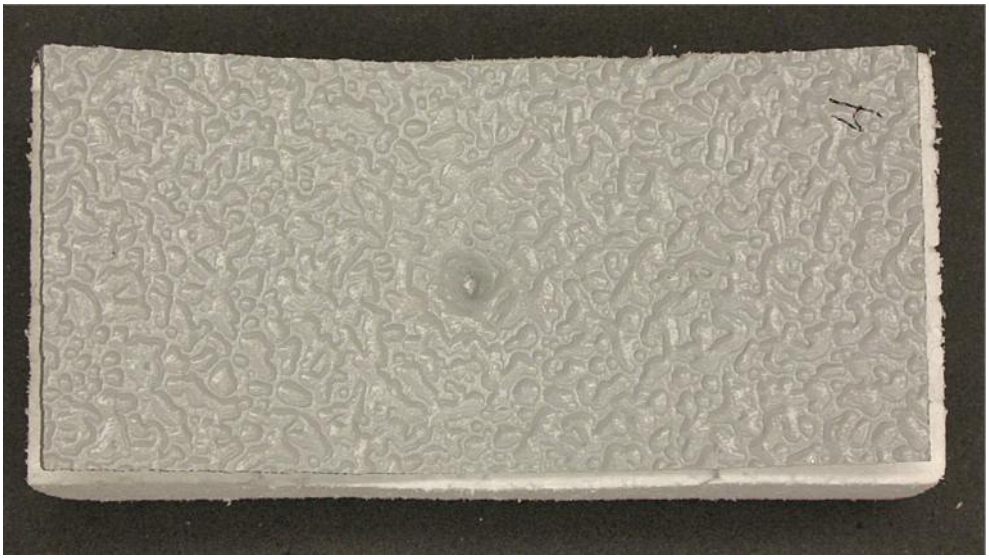


Picture 1. Test setup.

Picture 2. Impact striker.

Picture 3. Penetration striker


Picture 4. Typical damage after impact test.


Picture 5. Typical damage after penetration test.

Appendix 2

Details on the products, data supplied by Float-Tech

TECHNICAL DATA

PONTOON
The plastic floatation units are slotted into the aluminium profile to form a pontoon. It can come with brackets to allow it to be anchored with poles or chains/wire.

FLOTATION UNIT
The shell is blow moulded UV stabilised HDPE plastic (High Density PolyEthylene) with EPS (Expanded PolyStyrene) filling. EPS density is 22 kg/m3. The shell is very impact resistant with an anti slip surface.

C- AND T-PROFILES
Extruded anodised aluminium AW-6060-T6.

POLE BRACKETS AND HINGES
Manufactured from advanced engineered plastic (polyamide and glass fibre) for long life and durability. The composite material is extremely ware resistant.

FIXINGS
All bolts, nuts and washers are stainless steel 2343.

CORNERS
Manufactured in polypropylene. The corners have internal stainless steel reinforcement and fit flush to the deck with no sharp edges.

LANDING BOARD
5.0-mm anti slip patterned aluminium sheet fixed to the aluminium framing of the pontoon with stainless steel hinges and fixings.

STANDARD DIMENSIONS

Width (m)	Length (m)	Height (m)	Weight (kg)	Floating Capacity (kg)
1.2	3.0	0.22	66	534
1.2	4.2	0.22	89	751
1.2	6.0	0.22	128	1 072
2.4	3.0	0.22	124	1 076
2.4	4.2	0.22	167	1 513
2.4	6.0	0.22	243	2 157
3.6	3.0	0.22	175	1 642
3.6	4.2	0.22	245	2 275
3.6	6.0	0.22	338	3 262
4.8	4.2	0.22	327	3 060
4.8	6.0	0.22	420	4 380
6.0	4.2	0.22	378	3 805
6.0	6.0	0.22	537	5 463

STANDARD DIMENSIONS