polycon

Technical characteristics of the material

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Content

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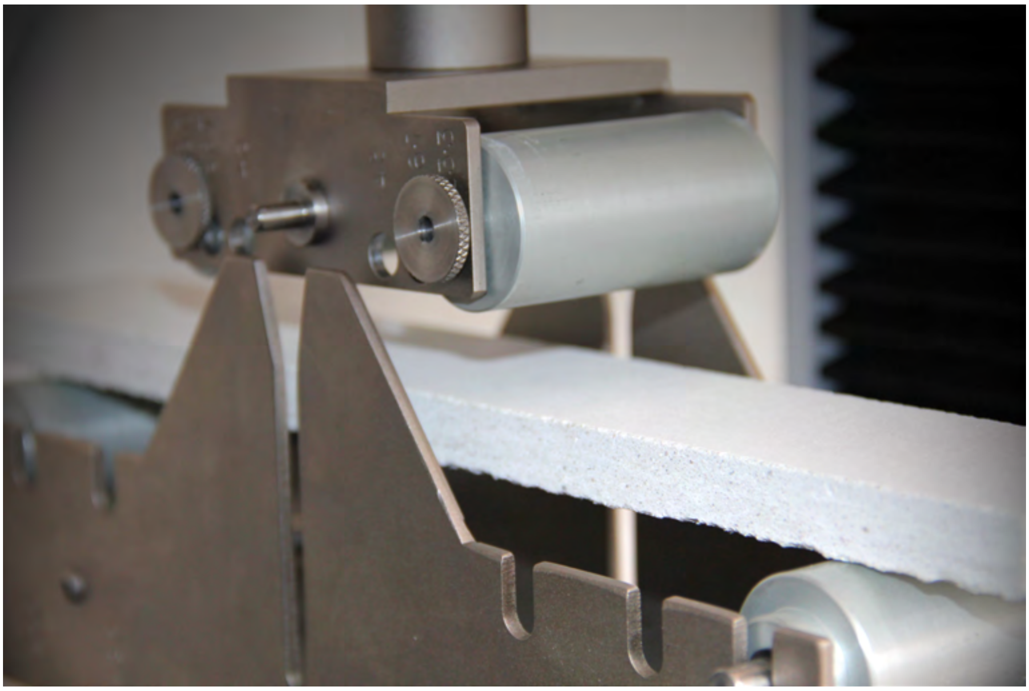
7.1 Basic material properties

Dimensions and tolerances

Dimensions		individual – as required
Shape and design		individual – as required
The thickness		individual – as required
The surface structure	standard	smooth, fine texture, coarser structure
	upon request	RECKLI, imprinting structure
		Graphic concrete
		Eluting (blasted) surface
		Individual – on request
Length tolerance	in lengths up to 2 000 mm	± 1,5 mm/m[1]
	In lengths over 2 000 mm	± 2,0 mm/m[1]
Width tolerance	in widths up to 1 000 mm	± 1,5 mm/m[1]
	In widths over 1 000 mm	± 2,0 mm/m[1]
Diagonal tolerance	in lengths up to 1 200 mm	± 2,5 mm/m[1]
	In lengths over 1 200 mm	± 3,0 mm/m[1]
Thickness tolerance	smooth plate (without structure)	± 1,5 mm/m[1]

Other material properties

Thermal expansion (coefficient)	7–12 × 10–6 K^{-1}
Specific weight	1.900–2.200 kg/m^3
Weight of 1 m^2 of thick. 13 mm	24–29 kg/m^2
Water absorption	≤ 13 %
Frost resistance	≥ 0,75
Tensile rupture (MOR)	8–15 N/mm^2
Elastic modulus	10–20 Gpa
Flammability	A1
Flame Spread Index	i_s = 0,0 m/m^{-1}
UV stability	UV resistant pigments



7.0 Technical characteristics of the material

7.2 Natural character

Polycon material is a composite material based on concrete, which is reinforced with glass alkali resistant fibers. This combination is achieved exceptional technical properties such as hardness, strength, durability, ductility, resistance to fire - Class A1 and more. The advantage of this material also consists of its low density and the possibility of producing thin slices or spatial elements. In the production are used as starting materials only high quality materials from reputable manufacturers (glass fibers, minerals and other raw materials), which provide top quality products and their unique and unique appearance.

Products made from Polycon material having a surface texture and appearance as exposed concrete and no further adjustments may have slight surface roughness, irregularities and shade structures, tension trajectories caverns and others that are with regard to the materials used purely natural characteristic and enhance the individuality and uniqueness of appearance the individual exposed surfaces. With these characteristic properties, unrepeatable and different appearance from commonly used materials with smooth artificial surface extends Polycon material fundamental options of technical and aesthetic requirements of customers.

7.0 Technical characteristics of the material

7.3 Possibilities of color and surface differences

Polycon material is a modern progressive natural material, which is popular mainly for its unique features and unique appearance. By making it differs from the commonly used large-sized materials, which is expected and required absolute geometric accuracy, flatness, and the same color over the entire surface and unified appearance (glass, metal, composite boards, and the like). It finds its application wherever it is desirable returns and preservation of nature and structure of the material and in order for the elements and surfaces are possible retain their uniqueness in a spirit of unity with nature and ecological thinking in the design and construction.

High requirements are imposed on the valid standards used for powder and liquid pigments and monitoring internal quality functional surfaces. Only the pigments which are suitable for dyeing materials containing cement. Pigments must be lightfast (UV) and weatherproof resistant. When color measurement and evaluation of measured values (L, b, delta-E) is required take into account the irregularity storage of raw materials, the moisture of the material, including humidity, status and degree of contamination of the measured surface, the intensity of a light source. In assessing the color must also take into account the effects of external factors and the natural processes of aging, where possible color changes cannot be considered as a material defect, as it is a natural process of maturation and aging. Color shade and visible surfaces of areas of individual components may also vary in relation to the incident angle and the light intensity.

When the difference of tonality glass-fiber reinforced concrete slabs it is important to note that the material and air humidity are their primary cause. Increased moisture has ultimately affect the color difference (darker shade) within the visible surfaces visible concrete (Polycon material is hygroscopic and therefore it absorbs and releases moisture, which can cause slight changes in color) that have not undergone conventional continuous temperature cycle on the facade. This process is characteristic of gray and white Portland cement, which can be amplified by the selected surface structure. The supporting and the surface layer made from white or gray Portland cement tends to absorb more moisture from the air in the early months after application (installing) and hold the moisture longer. When an objective assessment – the factors affecting values tonality (as the natural fluctuation of the raw materials, humidity and air panel, external temperature and dew point, pollution, light sources, etc.) must be taken into account. All colors have a natural feature - lighten during moisture desorption. Changes induced by aging, weathering and factors related to the environment are natural processes that cannot be in any way affected by production technology and therefore they cannot be considered as material defects.

Due to these characteristic material properties may get situation, in which the objectively compared presented sample plate of the project (whose age can be on the order of months) or model implementation which age or the way storage is different from new products or production within the first deliveries to the building. Usually the sample plate (sample implementation) is in lighter shade than the tonality of newly manufactured and supplied plates to the building. Since conditions of concrete appearance and color intensity during storage (temperature, humidity) as well as changes in the environment (shift from drier to wetter environments and vice versa) it is necessary to take this into account in the design and actual implementation. Increased differences in the intensity of tonality can be expected especially in the manufacture, supply and implementation in months with high humidity and lower temperatures. Residual moisture of manufacturing material and diffuse from air humidity is absorbed by the dispatched material and it is released much slower from internal material structures (products of gray Portland cement in this period can have very dark areas caused by concentrated moisture). This feature of fresh faced concrete with time is slowly losing, especially if it goes through the normal temperature cycle in the whole year. This feature is quite common for this type of material and therefore it cannot be considered as a defect.

7.0 Technical characteristics of the material

7.3 Possibilities of color and surface differences

It is necessary to count with the fact then this is impossible on the basis of a small sample element and particular natural material require then all the other elements were completely identical because it is a natural material wherein the contrast characteristic feature is the diversity of the material in the surface of the lot, etc. Because it is a natural material this is not possible to seek the best complete uniformity and stability. It is should be noted that all materials are subject of natural aging process since begin – their creation (or production) and so it is impossible within the short time (months, years, decades, etc.) retrospectively compare their appearance when they are exposed to different environments and on the surrounding influences.

Material's ability to react continuously to the external environment and eventually regain their characteristic appearance gives to those products the desired natural character due it they are selected and used. Objective natural material properties cannot be used as an assessment argument of their quality.

7.4 Thickness

For the objective evaluation of the nominal thickness of the material it is necessary to take into account that each product is manufactured by pressure spraying into molds. Manufacturing process and its technology are under constant monitoring, but neither while respecting all technological and control processes, the absolute product conformity in all parts, surfaces, edges, and faces transitions cannot be guarantee. Indication that the material can exhibit some fundamental differences enhances its unique natural character. Characteristics of nominal material thickness measurement are based on the average from the thickness measurements as described below for performing such measurement methods. There is also formulated an indicative table of the declared values of the permissible tolerance deviations of average measured nominal thickness of products. Uniformity and homogeneity of tolerance variations can be objectively assessed only in such types of products that allow the objective evaluation methods. These are the areas and locations of products which are completely smooth, without the surface structure. Only those Polycon products bearing with the imprinting matrix can be assessed and evaluated, which are produced on the same imprinting form or matrix and subsequently compared with each other individual variations of selected matrix. The surface structure is not uniform, not only in the context of functional surfaces exposed surfaces, but also in edges of each product. Disunity of thickness is given by imprinting matrix, then the deviation forms the basis of shape profile of the surface structure.

Spatial and shape Polycon product shall expect that the thickness of the products is greater in locations of connected surfaces and in the corners of the elements, because they are the most statically stressed parts of the external tension-carrying elements in critical areas such as joints and corners. A large amount of internal reinforcement material provides high durability and stability of the molded elements within the handling, transportation and installation.

7.0 Technical characteristics of the material

7.5 Caverns shrinkage cracks, tension trajectories

Glass-fiber reinforced concrete is a material whose matrix formed by gradual hydration of clinker minerals in cement. It is therefore a material whose final material properties are fully available after weeks or months. This must be taken into account for design and implementation of glass-fiber reinforced concrete elements.

Volume changes represent characteristics that need to be taken into account in the design and implementation. These are mainly the following:

Hydration and respectively chemical shrinking, which is related to the initial chemical reaction in which mixing water reacts with clinker minerals creating mostly amorphous calcium silicate hydrate compounds. As a result of these chemical reactions there is a contraction that is associated to the formation of extremely varied pore system.

Shrinkage associated with changes of glass-fiber reinforced concrete humidity. If the glass-fiber reinforced concrete is exposed permanently under water, it tends to acquire (positive volume changes) and conversely cement matrix shrinks during gradual drying. Then the final shrinkage values may amount, depending on the volume of cement phase, to 3 per mile (3 mm/m). Table of humidity and temperature effects on material is listed on page 197.

Classical thermal expansion related to changes in temperature. The standard value of coefficient of thermal expansion is – 10 × 10-6 × K-1.

Shaping – volume changes due to elastic-plastic deformation associated with power effects.

In practical terms, the volume changes associated with the drying are most relevant. A common result of these volume changes is the creation of so-called shrinkage cracks. Hairline cracks especially in the corners and edges of the products can become visible by the naked eye, but they have no effect for durability or quality. Volume changes of glass-fiber reinforced concrete are by no means the defect, but they are a natural part of the aging process. These changes are eliminated by using alkali-resistant glass fibers as internal reinforcement. It captures forces, respectively tension resulting from volume changes. It shall ensure that in addition to the visible wide cracks, the plurality of hairline cracks with a width of below 0,1 mm is created. They are both functional and aesthetically virtually meaningless.

Within the design and evaluation of the visible surfaces of Polycon products, it must be said that their purely natural appearance and structure is their primary argument It may have slight minor irregularities and shade structures, tension caverns trajectories concrete efflorescence, transmission of the glass fibers into the surface and more. These parameters are specific to the used materials and purely natural processes of aging, they enhance the uniqueness and uniqueness appearance of individual exposed surfaces and therefore they cannot be considered as a material defects.

7.0 Technical characteristics of the material

7.6 Shape deformation due to changes in temperature and humidity

Glass-fiber-concrete composite material is very stable. Nevertheless, during structure design it is necessary to allow for the fact that the material with natural character responds to external influences (hygroscopic). The main factors (to be taken into account in the design) are the thermal volume changes and volume changes in humidity.

Thermal volume changes

Although the material glass-fiber-concrete panels has a similar coefficient of thermal expansion 10,7e-6 [1/K](see Appendix 1) as a steel support structure 12,0e-6 [1/K], temperature effects cannot be completely ignored. It is necessary to consider the possibility unequal heating and cooling of the outer shell and supporting structure, etc. - See the indicative table (page 197) that shows the approximate values of dimensional stability of glass-fiber-concrete composite with respect to temperature changes and their effect on the material.

Moisture volume changes

As follows from the results of measurements, volume changes occur in glass-fiber-concrete composite relating with its variable humidity. It appears from the measurements that the volume changes are not linear to the degree of saturation of plates with water, and that changes near the full drying have a greater gradient than changes near the full saturation of the material. The following table describes the approximate value of the material behavior depending on various parameters, which indicate that moisture volume changes are very essential aspect in the design and implementation of support structures in the context of allowing free expansion of the material.

In general, the effects of thermal and moisture volume changes are more evident in shaped elements and the flat plates because the internal stress of the material (including external influences to shape) is not dispersed in the free space of plates, but its effect is limited by shaped profile of the product, their corner reinforcement or a combination of related areas. These influences affect the decomposition of internal and external tensions transmitted both individually and in combination. Other factors that must be taken into account when designing and objective evaluation include the type of surface structure, dimensions and shapes related areas because also these parameters affect the decomposition of material tension.

In general it can be concluded, that the design and implementation of shaped elements with regard to objective evaluation of shape and design uniformity shall take into account that any changes of external influences or their combinations (temperature, humidity, etc.) can affect the final shape design. During the design and implementation of supporting structures it is necessary to calculate the influence of temperature and humidity changes so that the substructure allows free expansion of material without restriction in all directions.

7.0 Technical characteristics of the material

7.6 Shape deformation due to changes in temperature and humidity

Orientation table of thermal expansion

Length of the element bm	The temp. diff.	5 °C	10 °C	15 °C	20 °C	25 °C	30 °C	35 °C	40 °C	45 °C	50 °C
0.50 bm	The relative change in element length	0.023 mm	0.045 mm	0.068 mm	0.090 mm	0.113 mm	0.135 mm	0.158 mm	0.180 mm	0.203 mm	0.225 mm
1.00 bm		0.045 mm	0.090 mm	0.135 mm	0.180 mm	0.225 mm	0.270 mm	0.315 mm	0.360 mm	0.405 mm	0.450 mm
1.50 bm		0.068 mm	0.135 mm	0.203 mm	0.270 mm	0.338 mm	0.405 mm	0.473 mm	0.540 mm	0.608 mm	0.675 mm
2.00 bm		0.090 mm	0.180 mm	0.270 mm	0.360 mm	0.450 mm	0.540 mm	0.630 mm	0.720 mm	0.810 mm	0.900 mm
2.50 bm		0.113 mm	0.225 mm	0.338 mm	0.450 mm	0.563 mm	0.675 mm	0.788 mm	0.900 mm	1.013 mm	1.125 mm
3.00 bm		0.135 mm	0.270 mm	0.405 mm	0.540 mm	0.675 mm	0.810 mm	0.945 mm	1.080 mm	1.215 mm	1.350 mm
3.50 bm		0.158 mm	0.315 mm	0.473 mm	0.630 mm	0.788 mm	0.945 mm	1.103 mm	1.260 mm	1.418 mm	1.575 mm
4.00 bm		0.180 mm	0.360 mm	0.540 mm	0.720 mm	0.900 mm	1.080 mm	1.260 mm	1.440 mm	1.620 mm	1.800 mm
4.50 bm		0.203 mm	0.405 mm	0.608 mm	0.810 mm	1.013 mm	1.215 mm	1.418 mm	1.620 mm	1.823 mm	2.025 mm
5.00 bm		0.225 mm	0.450 mm	0.675 mm	0.900 mm	1.125 mm	1.350 mm	1.575 mm	1.800 mm	2.025 mm	2.250 mm
5.50 bm		0.248 mm	0.495 mm	0.743 mm	0.990 mm	1.238 mm	1.485 mm	1.733 mm	1.980 mm	2.228 mm	2.475 mm
6.00 bm		0.270 mm	0.540 mm	0.810 mm	1.080 mm	1.350 mm	1.620 mm	1.890 mm	2.160 mm	2.430 mm	2.700 mm

Orientation table moisture expansion

Length of the element bm	Differ. of satur.	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %
0.50 bm	The relative change in element length	0.065 mm	0.130 mm	0.195 mm	0.260 mm	0.325 mm	0.390 mm	0.455 mm	0.520 mm	0.585 mm	0.650 mm
1.00 bm		0.130 mm	0.260 mm	0.390 mm	0.520 mm	0.650 mm	0.780 mm	0.910 mm	1.040 mm	1.170 mm	1.300 mm
1.50 bm		0.195 mm	0.390 mm	0.585 mm	0.780 mm	0.975 mm	1.170 mm	1.365 mm	1.560 mm	1.755 mm	1.950 mm
2.00 bm		0.260 mm	0.520 mm	0.780 mm	1.040 mm	1.300 mm	1.560 mm	1.820 mm	2.080 mm	2.340 mm	2.600 mm
2.50 bm		0.325 mm	0.650 mm	0.975 mm	1.300 mm	1.625 mm	1.950 mm	2.275 mm	2.600 mm	2.925 mm	3.250 mm
3.00 bm		0.390 mm	0.780 mm	1.170 mm	1.560 mm	1.950 mm	2.340 mm	2.730 mm	3.120 mm	3.510 mm	3.900 mm
3.50 bm		0.455 mm	0.910 mm	1.365 mm	1.820 mm	2.275 mm	2.730 mm	3.185 mm	3.640 mm	4.095 mm	4.550 mm
4.00 bm		0.520 mm	1.040 mm	1.560 mm	2.080 mm	2.600 mm	3.120 mm	3.640 mm	4.160 mm	4.680 mm	5.200 mm
4.50 bm		0.585 mm	1.170 mm	1.755 mm	2.340 mm	2.925 mm	3.510 mm	4.095 mm	4.680 mm	5.265 mm	5.850 mm
5.00 bm		0.650 mm	1.300 mm	1.950 mm	2.600 mm	3.250 mm	3.900 mm	4.550 mm	5.200 mm	5.850 mm	6.500 mm
5.50 bm		0.715 mm	1.430 mm	2.145 mm	2.860 mm	3.575 mm	4.290 mm	5.005 mm	5.720 mm	6.435 mm	7.150 mm
6.00 bm		0.780 mm	1.560 mm	2.340 mm	3.120 mm	3.900 mm	4.680 mm	5.460 mm	6.240 mm	7.020 mm	7.800 mm

Values are only approximate.

7.0 Technical characteristics of the material

7.7 Efflorescence

Efflorescence is a common property of all materials on the basis of concrete. Efflorescence is a white deposit, which appears on the surface and does not pose any structural problems.

Efflorescence is formed by migration of soluble salts (especially calcium hydroxide) which is present in the cement and through the pores in the structure it comes to the surface of the material. Either it happens during water evaporation (which makes a crystallized salt) or a soluble salt reacts with carbon dioxide in the atmosphere and creates the carbonate, which is precipitated and formed on the surface as chalky deposits called efflorescence.

Efflorescence is formed mostly by the effect of external sources, such as rain or condensation that are absorbed into the material.

Efflorescence is formed and often occur at low temperatures and high humidity because the evaporation is slower that allows a greater migration of salts to the surface. Also, the calcium hydroxide has a higher solubility at lower temperatures.

Removal of efflorescence

Efflorescence should not be removed during wet or cold conditions, because the dominant moisture may cause the reappearance of efflorescence. Their removal during suitable dry conditions will ensure that the water used for cleaning evaporates quickly, will not penetrate into material and does not have the ability to transmit more salts of the internal structure to its surface. Natural weathering over time removes soluble salts. The insoluble sediment (e. g., calcium carbonate) causes the greatest removal problems. Washing with a suitable cleaner is the only way to eliminate this kind of efflorescence.

Hydrochloric acid (salt), phosphoric acid and acetic acid are commonly used to remove efflorescence. 10 % or weaker solution or 20 % acetic acid solutions are commonly used. Several branded cleaners can also be used. These should be used in accordance with manufacturer's recommendations.

The areas that are to be stripped of efflorescence should be saturated with pure water to avoid the absorption of detergent. After application the detergent it is to be reckoned with some minutes of delay to perform a reaction and then the surface should be thoroughly rinsed with clean water. Scrubbing with a brush with hard bristles (not steel) may be necessary for hard deposits.

Cleaning is recommended within small areas on the order of a square meter. It should be noted that the cleaning agents can cause discoloration unless thoroughly flushed. Especially hydrochloric acid (salt) can create yellow spots.

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