Solico Engineering B.V.
Everdenberg 5A
NL-4902 TT Oosterhout
The Netherlands
Tel.: +31-162-462280 - Fax: +31-162-462707
Email: composites@solico.nl
Bank relation: Rabobank Oosterhout
Account number: NL33 RABO 0311 2315 27
Chamber of Commerce Breda no. 66511291

krafton® bridge deck plank 500.40

Mechanical Properties

Client	: krafton®
Author	: Ing. D.A. Mager; Ir. G. Alleman
Authorized	: Ing. H.C. van Uden
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1. Summary

In this report the mechanical properties of the pultruded glass fibre reinforced krafton® 500.40 bridge deck plank are reported. The mechanical properties of the bridge deck plank have been determined by means of tests. The tests were executed by TüV Rheinland (former TNO Quality services) and reported in report 11567R-11-32713 dated 11.08.2011.

The properties are summarized in Table 1.

In Issue 4 the characteristic shear force ($D_{char,200}$) due to a point load on 200x200 is recalculated, based on tests performed by krafton® on 21-12-2018.

		Units	krafton® 500.40
Dimensions	(b x h)	mm	500 x 40
Surface	(A)	mm²	5,571
Shear surface	(A_s)	mm²	1,836
Moment of inertia	(I)	mm⁴	1,238,296
Moment of resistance	(W)	mm³	51,119
Weight	(G)	kg/m²	20.0
Modulus of elasticity	(E_{av})	N/mm²	33,363
Flexural stress	($\sigma_{b,char}$)	N/mm²	431
Shear stress	(τ_{char})	N/mm²	44.9
Profile properties			
Flexural stiffness	(EI)	Nmm²/mm	82.63 x10⁶
Flexural strength	(M_b)	Nmm/mm	44,065
Shear strength	(D)	N/mm	165
Compressive strength	($N_{\perp,char}$)	N/mm/rib	870
Permissible shear force due to point load on 100 x 100	($D_{char,100}$)	N	36,542
Permissible shear force due to point load on 200 x 200	($D_{char,200}$)	N	90,289

Table 1

2. Product description

Pultruded, glass fibre reinforced polyester bridge deck plank.

Figure 1 shows the cross-section of the plank. The global dimensions are 500 x 40 x 5 mm. The thickness of the vertical ribs is 4 mm.

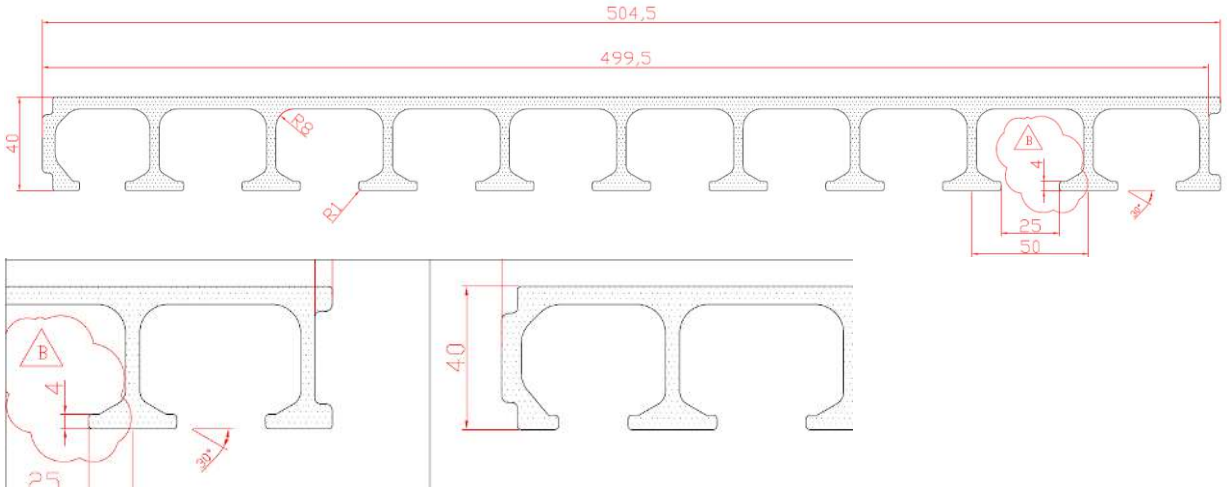

Figure 1

2.1. Geometric properties

Width	b	:	500	mm
Height	h	:	40	mm
Number of ribs	n	:	11	pcs
Distance between the ribs	d	:	50	mm
Surface	A	:	5,571	mm^2
Shear area	As	:	1,836	mm^2
Moment of inertia	I	:	1,238,296	mm^4
Section modulus	W	:	51,119	mm^3
Weight of plank	G	:	20.0	kg/m^2

3. Test

3.1. Test description

- Flexural strength and stiffness according to EN ISO 14125
- Shear strength analogous to EN ISO 14130
- Permissible compressive force due to point load
    - Point load on 100x50 mm analogous to the point load as used in EN1991-2.
- Permissible shear force due to a point load on 100x100 mm
    - Point load on 100x100 mm cf. EN 1991-2. The point load is applied on a plank with a 'large' span, right next to the supports.
- Permissible shear force due to a point load on 200x200 mm
    - Point load on 200x200 mm cf. unintended vehicle EN 1991-2. The point load is applied on a plank with a 'large' span, right next to the supports.

3.2. Test results

According to EN1990:2002 appendix D, the characteristic strength value is calculated from the average strength value minus k_n times the standard deviation. The values for k_n are used according to table D1 in EN1990:2002. The characteristic stiffness value is equal to the average measured stiffness value.

3.2.1. Flexural modulus

The flexural modulus is determined by determining the slope of the force-displacement curve. The slope is determined by taking two points on the graph and drawing a line between them. The points are chosen in the linear part of the curve. The E-modulus is calculated with the following formula:

$$\Delta y = \frac{\Delta F \times \ell^3}{48 \times E_b I} \qquad \rightarrow \qquad E_b = \frac{\Delta F \times \ell^3}{48 \times I \times \Delta y}$$

Wherein:

Δy	=	Displacement [mm]
ΔF	=	Force [N]
L	=	Span [mm]
E_b	=	Flexural modulus [N/mm^2]
I	=	Moment of inertia [mm^4]

TEST								CALCULATION	
Sample no.	**Span**	**y1**	**F1**	**y2**	**F2**	**D_y**	**D_F**	**I**	**E**
	[mm]	**[mm]**	**[N]**	**[mm]**	**[N]**	**[mm]**	**[N]**	**[mm^4]**	**[MPa]**
BS-1	1,300	2.9	2,416	11.6	10,340	8.7	7,924	1,238,296	33,589
BS-2	1,300	2.9	2,420	11.6	10,313	8.7	7,893	1,238,296	33,457
BS-3	1,300	2.9	2,381	11.6	10,200	8.7	7,819	1,238,296	33,144
BS-4	1,300	2.9	2,377	11.6	10,226	8.7	7,849	1,238,296	33,271
BS-5	1,300	2.9	2,496	11.6	10,365	8.7	7,869	1,238,296	33,355
							Average value [$E_{b,av}$]		33,363

Table 2

3.2.2. Flexural strength

The test values (F_{max}) are used to determine the flexural strength (σ_b) using the following formula:

$$\sigma_b = \frac{F_{max} \times \ell}{4 \times W}$$

Wherein: ℓ = Span

W = Section modulus

Sample no.	ℓ [mm]	W [mm^3]	F_{max} [N]	σ_b [N/mm^2]
BS-1	1,300	51,119	71,828	457
BS-2	1,300	51,119	70,905	451
BS-3	1,300	51,119	76,858	489
BS-4	1,300	51,119	73,810	469
BS-5	1,300	51,119	72,646	462
			Average value [$\sigma_{b,av}$]	466
			Standard deviation [s]	15
			Characteristic value [$\sigma_{b,char}$]	431

Table 3

The characteristic value is determined from the average value minus 2.33 x the standard deviation.

3.2.3. Shear strength

The test values (F_{max}) are used to determine the shear strength (τ) by the following formula:

$$\tau = \frac{F_{max}}{2 \times A_s}$$

Test no.	ℓ [mm]	A_s [mm^2]	F_{max} [N]	τ [N/mm^2]
ILSS-1	200	1,836	172,969	47
ILSS -2	200	1,836	186,513	51
ILSS 3	200	1,836	193,652	53
ILSS 4	200	1,836	185,678	51
ILSS -5	200	1,836	183,462	50
			Average value [τ_{av}]	50
			Standard deviation [s]	2.2
			Characteristic value [$\sigma_{b,char}$]	44.9

Table 4

The characteristic value is determined from the average value minus 2.33 x the standard deviation.

3.2.4. Shear strength for a concentrated load at 100 x 100 mm

The test results (F_{max}) are used to determine the shear strength (D_{100}) by means of the following formula:

$$D = \frac{F_{max} \times (\ell - \ell_0)}{\ell}$$

This only applies to a load on 100 x 100 mm. The value ℓ_0 is equal to half the length of the point load surface, plus the distance between the support and the edge of the point load.

Test no.	ℓ [mm]	ℓ_0 [mm]	F_{max} [N]	D [N/mm²]
DS 1_3.4	1,000	55	41,166	38,902
DS 2_3.4	1,000	55	41,901	39,596
DS 3_3.4	1,000	55	40,739	38,498
DS 4_3.4	1,000	55	39,397	37,230
DS 5_3.4	1,000	55	40,757	38,515
			Average value [$D_{av,100}$]	38,548
			Standard deviation [s]	861
			Characteristic value [$D_{char,100}$]	36,542

Table 5

The characteristic value is determined from the average value minus 2.33 x the standard deviation.

3.2.5. Shear strength for a concentrated load at 200 x 200 mm

The test results ($F_{failure}$) are used to determine the shear strength (D_{200}) by means of the following formula:

$$D_{200} = \frac{F_{failure} \times (l - l_0)}{l}$$

This only applies to a load on 200 x 200 mm. The value ℓ_0 is equal to half the length of the point load surface, plus the distance between the support and the edge of the point load.

Test no.	ℓ [mm]	ℓ_0 [mm]	$F_{failure}$ [N]	D [N/mm^2]
200x200_1	1,000	105	102,690	91,908
200x200_2	1,000	105	107,690	96,383
200x200_3	1,000	105	104,070	93,143
200x200_4	1,000	105	107,670	96,365
200x200_5	1,000	105	105,770	94,664
200x200_6	1,000	105	110,280	98,701
			Average value [$D_{av,200}$]	95,194
			Standard deviation [s]	2250
			Characteristic value [$D_{char,200}$]	90,289

Table 6

The characteristic value is determined from the average value minus 2.18 x the standard deviation.

3.2.6. Compressive strength under a concentrated load

The compressive strength has been tested with a pressure punch of 100 x 50 mm. The measured force (Fmax) is divided by the number of supporting ribs and the length of the punch (50 mm). The resulting force per mm of rib can be used to evaluate any point load.

Test no.	F_{max} [N]	$N_{\perp,max}$ [N/mm/rib]
DS1	97,622	976
DS2	96,289	963
DS3	98,280	983
DS4	89,340	893
DS5	98,913	989
Average value [$N_{\perp,av}$]		961
Standard deviation [s]		39
Characteristic value [$N_{\perp,char}$]		870

Table 7

The characteristic value is determined from the average value minus 2.33 x the standard deviation.