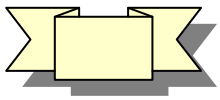

GRISPE

Guidelines and **R**ecommendations for **I**ntegrating **S**pecific **P**rofiled steel sheets in the **E**urocodes
(**GRISPE**)

WP1 Doc 2 Final Verion 01

WP1 Test program definition

Working Package 1

Deliverable D 1.2

DOCUMENT CONTROL INFORMATION AND ARCHIVING

Guidelines and Recommandations for Integrating Specific Profiled Steels sheets in the Eurocodes (GRISPE)

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Deliverable	
D 1.2 WP1 Test program definition	***Due date : 31.12.2013*** ***Completion date: 27.12.2013***

1. INTRODUCTION

1.1. Aim of the tests

The aim of the tests is:
- to acquire data for analyzing the effect of embossment and indentations on the structural behaviour: resistance and stiffness of the steel decks;
- to acquire data for analyzing the bending resistance of sheeting with outwards stiffener in the upper flange.

1.2. General

In order to acquire the data for analyzing the effect of embossment and indentations, two different profiles with different shapes of embossment/indentations (decking 1 and decking 2) will be tested.
The same profiles will be tested with and without embossment/indentations, with two different thicknesses of the sheets.

In order to acquire data for analyzing the bending resistance of sheeting with outwards stiffener in the upper flange, one profile with outwards stiffener in the upper flange will be tested, with two different thicknesses.

The global behaviour of profiles will be tested according to EN 1993-1-3, Annex A:
- single span tests,
- internal support tests,
- end support tests.

The local behaviour of sheets with indentation/embossment will be tested on coupon tests.

1.3 Preliminary measurements

The following geometrical dimensions of the test samples have to be controlled:

- Core thickness (without zinc) and yield strength measured in relation with core thickness. The core thickness may be measured after chemical removal of the zinc or by mean of any device guarantying an equivalent precision of measure, as for example electro-magnetic device,
- Overall dimensions of sheeting cross section: width and height, measured with 1 mm precision.

1.4 General remarks concerning single span tests, internal support tests and end support tests procedure

- The test procedure is based on the EN 1993-1-3 Annex A principles, however taking into account the amendments prepared by the Evolution Group EN 1993-1-3
- Test data to acquire are numerical values of corresponding loads and deflections, as well as corresponding diagrams
- The load will be applied with control of displacements

- Zeroing displacement sensors will be made after installation of the test sample, before installation of the loading system
- At each step of loading the displacements will be noted after stabilization of loading
- The graduation of the loading steps will be set and adjusted during each new type of test. Usually, in the initial stage the steps should be short, afterwards, in linear stage, they can be increased and it is recommended to shorten the steps at the beginning of non-linear stage and shortly after reaching maximal value, and afterwards it may be increased again
- In "single span tests" the loading will be applied up to collapse
- In "internal support tests" the loading will be applied up to deflection at least ≅ s/10
- During "end support tests" the loading will be slightly extended beyond ultimate maximum load
- Two kind of profiles will be tested:
  1) profiles with and without embossment/indentations
  2) profiles with outwards stiffener

2 TESTING PRINCIPLES

2.1 Testing on sheeting

2.1.1 Single span tests

Tests set-up:

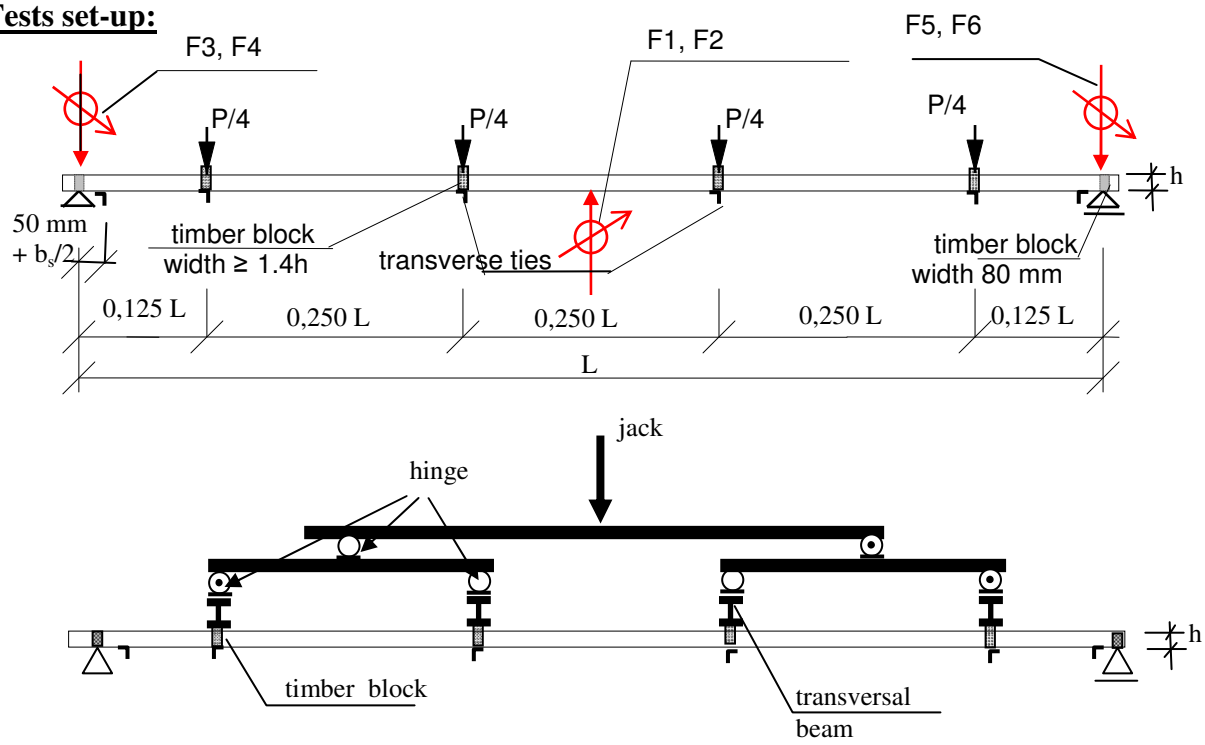


Fig. 2.1.1.1 – Test set-up for single span tests

Key:

○	fixe hinge
⊙	mobile hinge (free horizontal displacement)
b_s	support width

Transverse ties: folded angles 30x30x1. The ties are reusable for several different tests.

P = applied external load on the sample (jack force + accessories weight)
Fi = displacement sensors:
- at the mid-span - F1, F2
- at the end supports:
  left side: F3, F4
  right side: F5, F6

The displacement sensors F1 and F2 are situated under bottom flanges of edge ribs.
The displacement sensors F3 to F6 are situated above upper flanges of edge ribs.

Dimension of timber blocs:
- at the supports: $h_{timber} = h_{sheeting}$, thickness $b_{timber} = 80$ mm
- under transversal beams $h_{timb} = h_{sheeting} + 5$ mm, thickness $b_{timber} = 1.4\ h_{sheeting}$

The length of timber block is adjusted to the internal width of the sheeting being in contact with the timber block (taking into account the rounded corners).

The surface of the timber blocks being in contact with sheeting flange is adjusted to the stiffeners in the flange.

The samples are placed freely at the supports without fixing.

Remarks:
In order to avoid web crippling at the supports and under the transversal beam, the timber blocks are used.
In order to avoid spreading of the sheets, the transverse ties (for example folded angles 35x35x1 fixed to the sheet edges with hex-head self-tapping screws d ≥ 4.2 mm) are used (see Fig. 2.1.1.2)

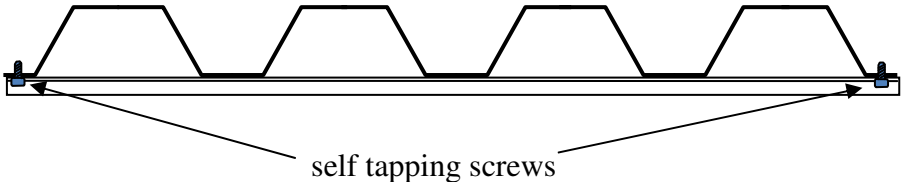


Fig. 2.1.1.2 – Fixation of the ties

2.1.2 Internal support tests

Test set-up:

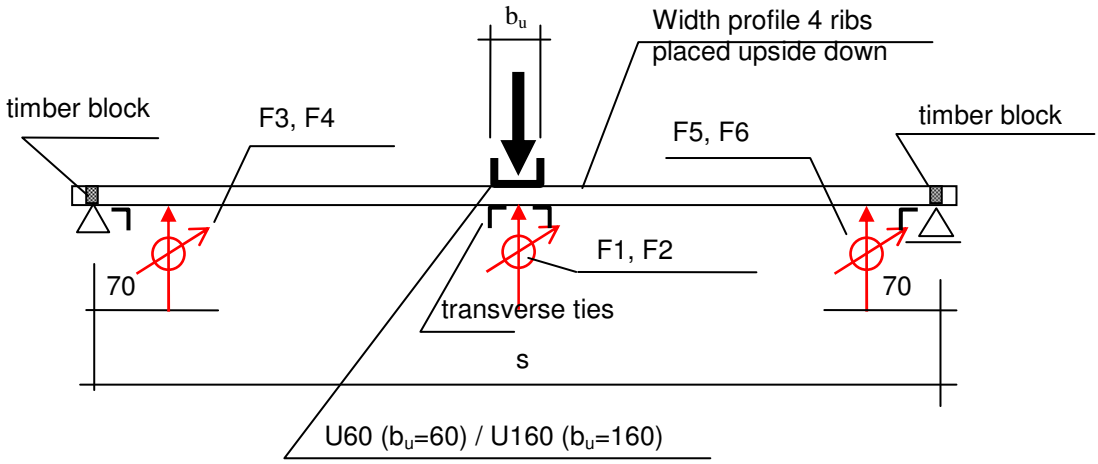


Fig. 2.1.1.2 – Test set-up for internal support tests

Transverse ties: folded angles 30x30x1. The ties are reusable for different tests.

Fi = displacement sensors:
- at the mid-span - F1, F2
- at the end supports:
  left side: F3, F4
  right side: F5, F6

All displacement sensors are situated under bottom flanges of edge ribs.
Dimensions of timber blocs at the supports:
height $h_{timber} = h_{sheeting}$
thickness of b_{timber} = 80 mm

The length of timber block is adjusted to the internal width of the sheeting being in contact with the timber block (taking into account the rounded corners)
The surface of the timber block being in contact with sheeting flange should be also adjusted to the stiffeners in the flange.

The samples are placed freely on the supports without fixing.

Remarks:
In order to avoid web crippling at the supports, the timber blocks are used.
In order to avoid spreading of the sheets, the transverse ties (for example folded angles 35x35x1 fixed to the sheet edges with hex-head self-tapping screws d ≥ 4.2 mm) are used (see Fig. 2.1.1.2)

2.1.3 End support tests

Test set-up:

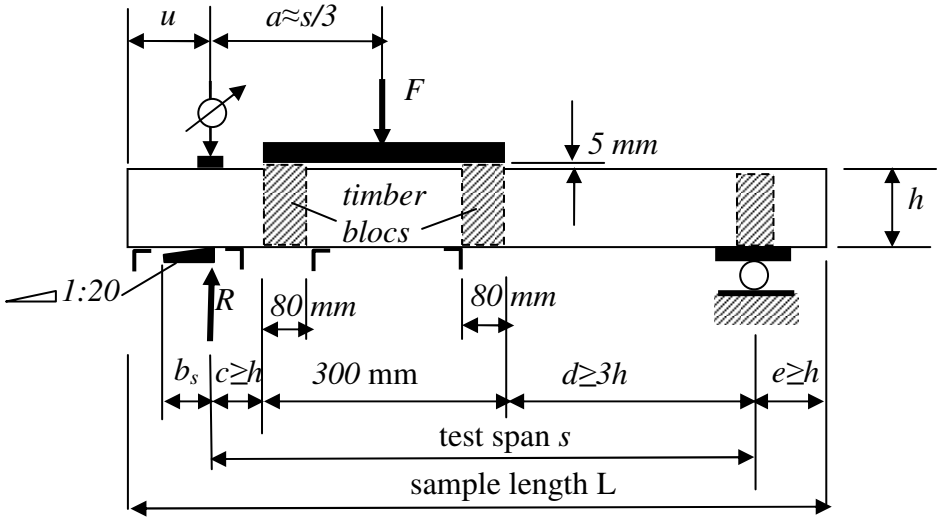


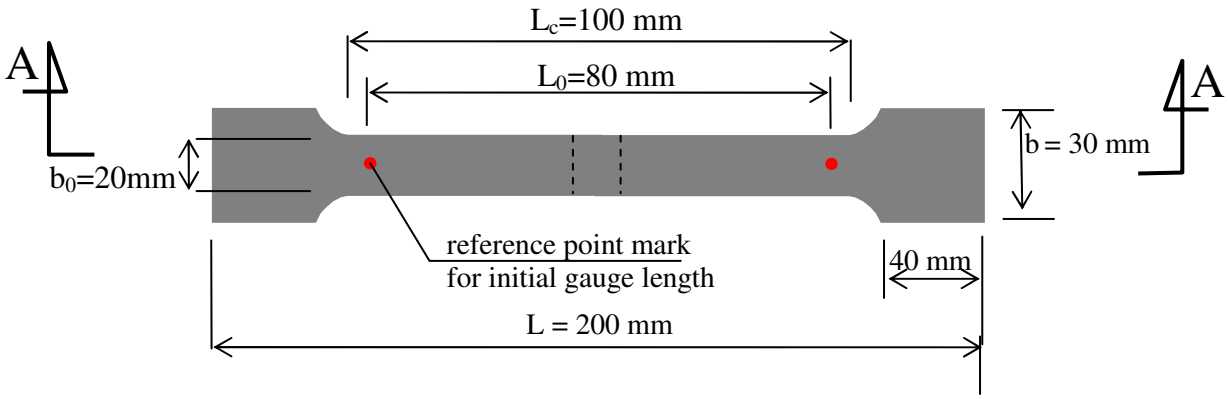
Fig. 2.1.3.1 – Test set-up for end support test

Dimension of timber blocs:
height of timber blocs situated at the supports: $h_{timber} = h_{sheeting}$
height of timber blocs situated under transversal beams $h_{timb} = h_{sheeting} + 5$ mm
thickness $b_{timber} = 80$ mm
The length of timber block is adjusted to the internal width of the sheeting being in contact with the timber block (taking into account the rounding corners).
The surface of the timber block being in contact with sheeting flange is adjusted to the stiffeners in the flange.

Remarks:
In order to avoid web crippling at the support opposite to the tested support and under the transversal beam, the timber blocks are used.
In order to avoid spreading of the sheets, the transverse ties (for example folded angles 35x35x1 fixed to the sheet edges with hex-head self-tapping screws d ≥ 4.2 mm) are used (see Fig. 2.1.1.2)

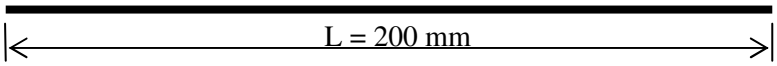
2.2 Testing on coupon tests

The tensile testing will be realized according to EN ISO 8692-1.



Section A-A

a) plate coupons



b) coupons with indentation

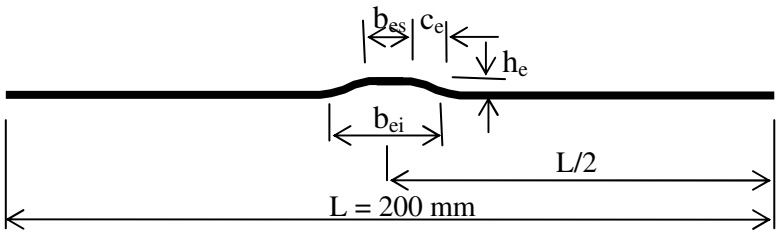


Fig. 2.2.1 Dimensions of coupons

Key:

L = total length

L_c = parallel length

L_0 = initial gauge length

b = total width

b_0 = width of the parallel reduced part

The dimensions of embossment b_{ei}, b_{es} and h_e are given in the Table 3.3.1.

3 Specification of samples

3.1 Preparation of the sheeting samples for single span tests, internal support tests and end support tests

General requirements:

- The sheeting samples having the same thickness must be produced with the same coil
- The samples must be composed of integer number of ribs:
  . as shown in the Fig. 3.1.1 when lateral edges are in tension
  . as shown in the Fig. 3.1.2 when lateral edges are in compression

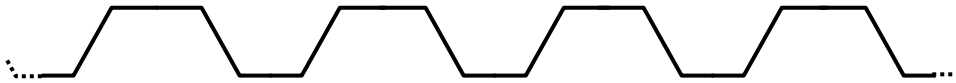


Fig. 3.1.1 Principle of cutting of the lateral edges in tension (the parts to remove are drawn in dotted lines)

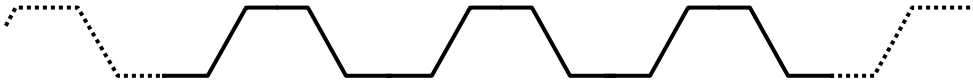


Fig. 3.1.2 Principle of cutting of the lateral edges in compression(the parts to remove are drawn in dotted lines)

3.2 Specification of sheeting

3.2.1 Decking 1

PCB 80 from BACACIER SAS

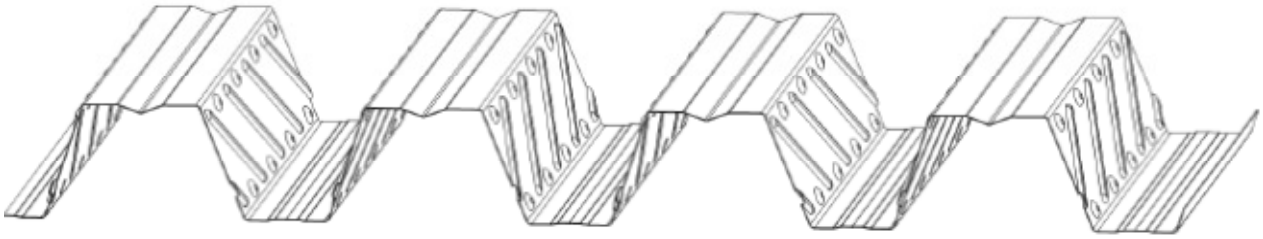


Fig. 3.2.1.1 General view

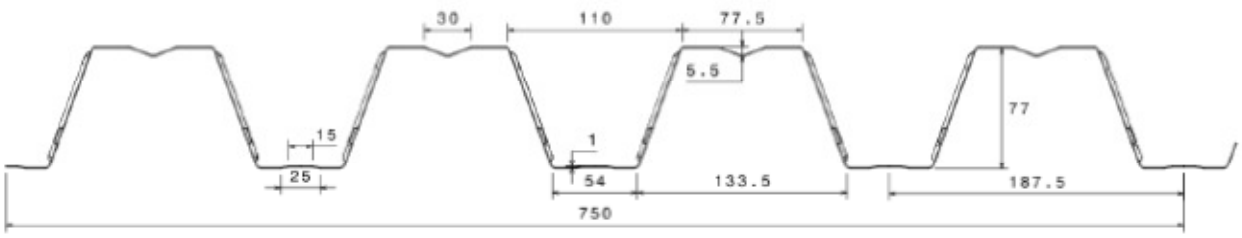


Fig. 3.2.1.2 Cross section

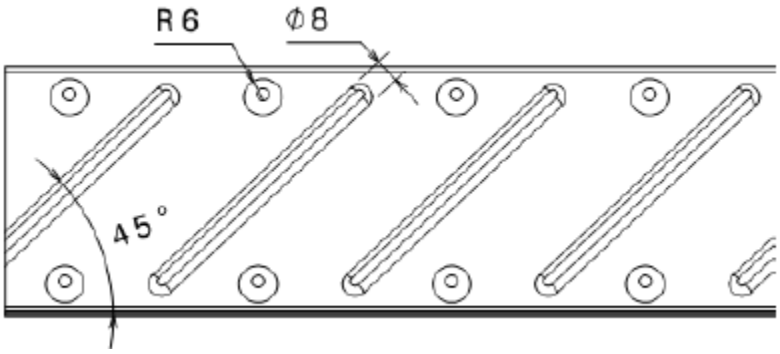


Fig. 3.2.1.3 Indentation/embossment

Table 3.2.1.1
Profiles without embossments
t=0.75 mm

Profiles without embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-1-075-1	3500	3700	cf Fig. 3.1.1	0.75
		PF-1-075-2				
		PF-1-075-3				
	Inter-mediate support b_u= 60 mm	IS6-1-075-11	500	700	cf Fig. 3.1.2	
		IS6-1-075-12				
		IS6-1-075-21	1100	1300		
		IS6-1-075-22				
		IS6-1-075-41	1700	1900		
		IS6-1-075-42				
	Inter-mediate support b_u= 160 mm	IS16-1-075-11	500	700		
		IS16-1-075-12				
		IS16-1-075-21	1100	1300		
		IS16-1-075-22				
		IS16-1-075-41	1700	1900		
		IS16-1-075-42				
	End support	ES-1-075-1	700	900	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-1-075-2				
		ES-1-075-3				

Table 3.2.1.2
Profiles without embossments
t=1.00 mm

Profiles without embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-1-100-1	3500	3700	cf Fig. 3.1.1	1.00
		PF-1-100-2				
		PF-1-100-3				
	Inter-mediate support b_u= 60 mm	IS6-1-100-11	500	700	cf Fig. 3.1.2	
		IS6-1-100-12				
		IS6-1-100-21	1100	1300		
		IS6-1-100-22				
		IS6-1-100-41	1700	1900		
		IS6-1-100-42				
	Inter-mediate support b_u= 160 mm	IS16-1-100-11	500	700		
		IS16-1-100-12				
		IS16-1-100-21	1100	1300		
		IS16-1-100-22				
		IS16-1-100-41	1700	1900		
		IS16-1-100-42				
	End support	ES-1-100-1	700	900	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-1-100-2				
		ES-1-100-3				

Table 3.2.1.3
Profiles with embossments
t=0.75 mm

Profiles with embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-1e-075-1	3500	3700	cf Fig. 3.1.1	0.75
		PF-1e-075-2				
		PF-1e-075-3				
	Inter-mediate support b_u= 60 mm	IS6-1e-075-11	500	700	cf Fig. 3.1.2	
		IS6-1e-075-12				
		IS6-1e-075-21	1100	1300		
		IS6-1e-075-22				
		IS6-1e-075-41	1700	1900		
		IS6-1e-075-42				
	Inter-mediate support b_u= 160 mm	IS16-1e-075-11	500	700		
		IS16-1e-075-12				
		IS16-1e-075-21	1100	1300		
		IS16-1e-075-22				
		IS16-1e-075-41	1700	1900		
		IS16-1e-075-42				
	End support	ES-1e-075-1	700	900	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-1e-075-2				
		ES-1e-075-3				

Table 3.2.1.4
Profiles with embossments
t=1.00 mm

Profiles with embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-1e-100-1	3500	3700	cf Fig. 3.1.1	1.00
		PF-1e-100-2				
		PF-1e-100-3				
	Inter-mediate support b_u= 60 mm	IS6-1e-100-11	500	700	cf Fig. 3.1.2	
		IS6-1e-100-12				
		IS6-1e-100-21	1100	1300		
		IS6-1e-100-22				
		IS6-1e-100-41	1700	1900		
		IS6-1e-100-42				
	Inter-mediate support b_u= 160 mm	IS16-1e-100-11	500	700		
		IS16-1e-100-12				
		IS16-1e-100-21	1100	1300		
		IS16-1e-100-22				
		IS16-1e-100-41	1700	1900		
		IS16-1e-100-42				
	End support	ES-1e-100-1	700	900	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-1e-100-2				
		ES-1e-100-3				

Table 3.2.1.5
Complementary detailed information for
the end support set-up (see Fig. 2.1.3.1)

h mm	s mm	a mm	c mm	d mm	u mm	e mm	L mm	b_s mm
77	700	230	80	320	80	120	900	60

3.2.2 Decking 2

PML 60 from JORIS IDE S.A.

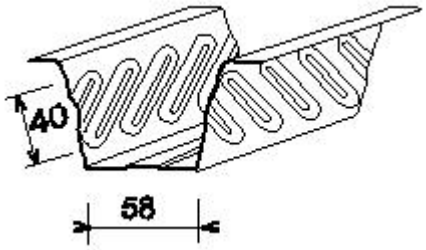


Fig. 3.2.2.1 View on common rib

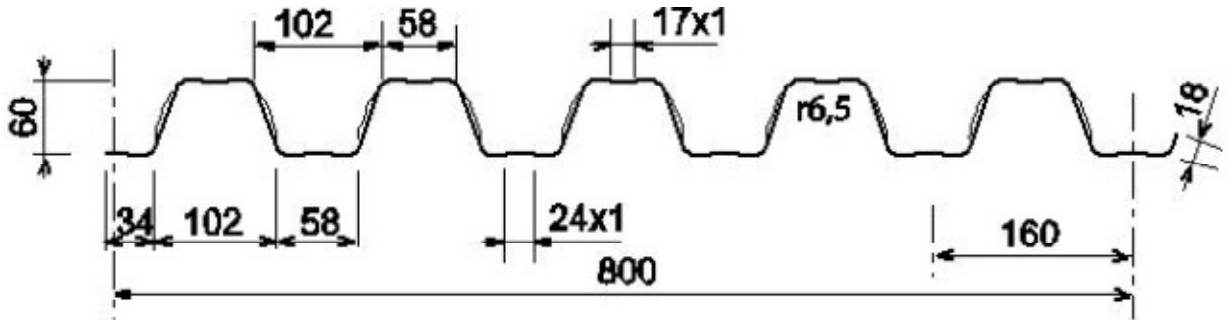


Fig. 3.2.2.2 Cross section

Table 3.2.2.1
Profiles without embossments
t=0.75 mm

Profiles without embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-2-075-1	3000	3200	cf Fig. 3.1.1	0.75
		PF-2-075-2				
		PF-2-075-3				
	Inter-mediate support b_u= 60 mm	IS6-2-075-11	400	600	cf Fig. 3.1.2	
		IS6-2-075-12				
		IS6-2-075-21	950	1150		
		IS6-2-075-22				
		IS6-2-075-41	1500	1700		
		IS6-2-075-42				
	Inter-mediate support b_u= 160 mm	IS16-2-075-11	400	600		
		IS16-2-075-12				
		IS16-2-075-21	950	1150		
		IS16-2-075-22				
		IS16-2-075-41	1500	1700		
		IS16-2-075-42				
	End support	ES-2-075-1	650	850	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-2-075-2				
		ES-2-075-3				

Table 3.2.2.2
Profiles without embossments
t=1.00 mm

Profiles without embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-2-100-1	3000	3200	cf Fig. 3.1.1	1.00
		PF-2-100-2				
		PF-2-100-3				
	Inter-mediate support b_u= 60 mm	IS6-2-100-11	400	600	cf Fig. 3.1.2	
		IS6-2-100-12				
		IS6-2-100-21	950	1150		
		IS6-2-100-22				
		IS6-2-100-41	1500	1700		
		IS6-2-100-42				
	Inter-mediate support b_u= 160 mm	IS16-2-100-11	400	600		
		IS16-2-100-12				
		IS16-2-100-21	950	1150		
		IS16-2-100-22				
		IS16-2-100-41	1500	1700		
		IS16-2-100-42				
	End support	ES-2-100-1	650	850	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-2-100-2				
		ES-2-100-3				

Table 3.2.2.3
Profiles with embossments
t=0.75 mm

Profiles with embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-2e-075-1	3000	3200	cf Fig. 3.1.1	0.75
		PF-2e-075-2				
		PF-2e-075-3				
	Inter-mediate support b_u= 60 mm	IS6-2e-075-11	400	600	cf Fig. 3.1.2	
		IS6-2e-075-12				
		IS6-2e-075-21	950	1150		
		IS6-2e-075-22				
		IS6-2e-075-41	1500	1700		
		IS6-2e-075-42				
	Inter-mediate support b_u= 160 mm	IS16-2e-075-11	400	600		
		IS16-2e-075-12				
		IS16-2e-075-21	950	1150		
		IS16-2e-075-22				
		IS16-2e-075-41	1500	1700		
		IS16-2e-075-42				
	End support	ES-2e-075-1	650	850	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-2e-075-2				
		ES-2e-075-3				

Table 3.2.2.4
Profiles with embossments
t=1.00 mm

Profiles with embossments			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-2e-100-1	3000	3200	cf Fig. 3.1.1	1.00
		PF-2e-100-2				
		PF-2e-100-3				
	Inter-mediate support b_u= 60 mm	IS6-2e-100-11	400	600	cf Fig. 3.1.2	
		IS6-2e-100-12				
		IS6-2e-100-21	950	1150		
		IS6-2e-100-22				
		IS6-2e-100-41	1500	1700		
		IS6-2e-100-42				
	Inter-mediate support b_u= 160 mm	IS16-2e-100-11	400	600		
		IS16-2e-100-12				
		IS16-2e-100-21	950	1150		
		IS16-2e-100-22				
		IS16-2e-100-41	1500	1700		
		IS16-2e-100-42				
	End support	ES-2e-100-1	650	850	cf Fig. 3.1.1 Fig. 2.1.3.1	
		ES-2e-100-2				
		ES-2e-100-3				

Table 3.2.2.5
Complementary detailed information for
the end support set-up (see Fig. 2.1.3.1)

h mm	s mm	a mm	c mm	d mm	u mm	e mm	L mm	b_s mm
60	650	230	80	270	80	120	850	60

3.2.3 Decking 3

ComFlor® 80 from TataSteel

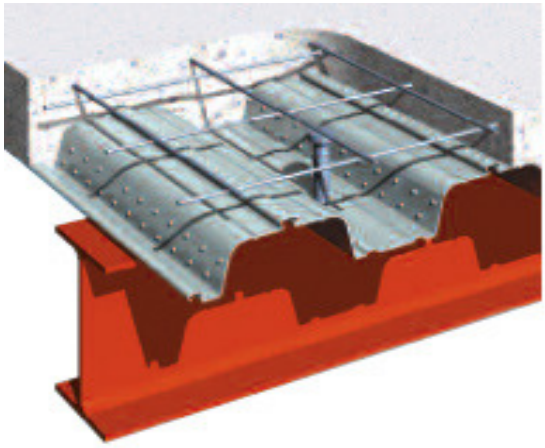


Fig. 3.2.3.l General view

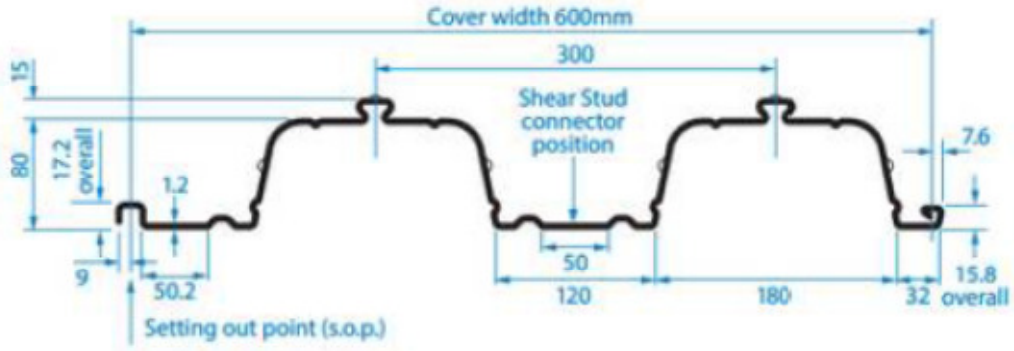


Fig. 3.2.3.2 Cross section

Table 3.2.3.1
Profiles with outwards stiffener
t=0.90 mm

Sheeting with outwards stiffener			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-3-090-1	4000	4200	cf Fig. 3.1.1	0.90
		PF-3-090-2				
		PF-3-090-3				
		PF-3-090-4				

Table 3.2.3.2
Profiles with outwards stiffener
t=1.20 mm

Sheeting with outwards stiffener			Dimensions			
			Length		Width	t_N
			span	sheet		
Ref.	Type	Name	mm	mm		mm
EC3	span positive flexion	PF-3-120-1	4000	4200	cf Fig. 3.1.1	1.20
		PF-3-120-2				
		PF-3-120-3				
		PF-3-120-4				

3.3 Specification of coupons for tensile testing

Table 3.3.1 Coupon tests for analysis of indentation/embossment influence [*]

Notes:
These coupons are provided by JORIS IDE
These coupons are prepared with steel grade S350GD, thicknesses t_N = 0.75 mm and 1.00 mm

Ref.	h_e	c_e	b_{es}	b_{ei}	t_N
	mm	mm	mm	mm	mm
TT-e-075-0-0-0-1[**]	0	0	0	0	0.75
TT-e-075-0-0-0-2[**]	0	0	0	0	0.75
TT-e-075-0-0-0-3[**]	0	0	0	0	0.75
TT-e-075-1-1-0-1	1	1	2	0	0.75
TT-e-075-1-1-0-2	1	1	2	0	0.75
TT-e-075-1-1-0-3	1	1	2	0	0.75
TT-e-075-1-1-10-1	1	1	10	10	0.75
TT-e-075-1-1-10-2	1	1	10	10	0.75
TT-e-075-1-1-10-3	1	1	10	10	0.75
TT-e-075-2-2-0-1	2	2	4	0	0.75
TT-e-075-2-2-0-2	2	2	4	0	0.75
TT-e-075-2-2-0-3	2	2	4	0	0.75
TT-e-075-2-2-10-1	2	2	10	10	0.75
TT-e-075-2-2-10-2	2	2	10	10	0.75
TT-e-075-2-2-10-3	2	2	10	10	0.75
TT-e-075-3-3-0-1	3	3	6	0	0.75
TT-e-075-3-3-0-2	3	3	6	0	0.75
TT-e-075-3-3-0-3	3	3	6	0	0.75
TT-e-075-3-3-10-1	3	3	10	10	0.75
TT-e-075-3-3-10-2	3	3	10	10	0.75
TT-e-075-3-3-10-3	3	3	10	10	0.75
TT-e-075-4-4-0-1	4	4	8	0	0.75
TT-e-075-4-4-0-2	4	4	8	0	0.75
TT-e-075-4-4-0-3	4	4	8	0	0.75
TT-e-075-4-4-10-1	4	4	10	10	0.75
TT-e-075-4-4-10-2	4	4	10	10	0.75
TT-e-075-4-4-10-3	4	4	10	10	0.75

Ref.	h_e	c_e	b_{es}	b_{ei}	t_N
	mm	mm	mm	mm	mm
TT-e-100-0-0-0-1[**]	0	0	0	0	1.00
TT-e-100-0-0-0-2[**]	0	0	0	0	1.00
TT-e-100-0-0-0-3[**]	0	0	0	0	1.00
TT-e-100-1-1-0-1	1	1	2	0	1.00
TT-e-100-1-1-0-2	1	1	2	0	1.00
TT-e-100-1-1-0-3	1	1	2	0	1.00
TT-e-100-1-1-10-1	1	1	10	10	1.00
TT-e-100-1-1-10-2	1	1	10	10	1.00
TT-e-100-1-1-10-3	1	1	10	10	1.00
TT-e-100-2-2-0-1	2	2	4	0	1.00
TT-e-100-2-2-0-2	2	2	4	0	1.00
TT-e-100-2-2-0-3	2	2	4	0	1.00
TT-e-100-2-2-10-1	2	2	10	10	1.00
TT-e-100-2-2-10-2	2	2	10	10	1.00
TT-e-100-2-2-10-3	2	2	10	10	1.00
TT-e-100-3-3-0-1	3	3	6	0	1.00
TT-e-100-3-3-0-2	3	3	6	0	1.00
TT-e-100-3-3-0-3	3	3	6	0	1.00
TT-e-100-3-3-10-1	3	3	10	10	1.00
TT-e-100-3-3-10-2	3	3	10	10	1.00
TT-e-100-3-3-10-3	3	3	10	10	1.00
TT-e-100-4-4-0-1	4	4	8	0	1.00
TT-e-100-4-4-0-2	4	4	8	0	1.00
TT-e-100-4-4-0-3	4	4	8	0	1.00
TT-e-100-4-4-10-1	4	4	10	10	1.00
TT-e-100-4-4-10-2	4	4	10	10	1.00
TT-e-100-4-4-10-3	4	4	10	10	1.00

[*] the samples are cut off from a plate sheet and the embossments are formed afterwards by stumping (see Fig. 2.2.1)

[**] plate samples (without embossment)

Table 3.3.2 Coupon tests (tensile testing on plate coupons) in rapport with decking 1 (PCB 80) and decking 2 (PML 60)

Ref.	t_N mm
TT-1-075-1	0.75
TT-1-075-2	0.75
TT-1-075-3	0.75
TT-1-075-4	0.75
TT-1-075-5	0.75
TT-1-100-1	1.00
TT-1-100-2	1.00
TT-1-100-3	1.00
TT-1-100-4	1.00
TT-1-100-5	1.00
TT-2-075-1	0.75
TT-2-075-2	0.75
TT-2-075-3	0.75
TT-2-075-4	0.75
TT-2-075-5	0.75
TT-2-100-1	1.00
TT-2-100-2	1.00
TT-2-100-3	1.00
TT-2-100-4	1.00
TT-2-100-5	1.00

Table 3.3.3 Coupon tests (tensile testing on plate coupons) for analysis of outwards stiffener behaviour

Note:
These coupons shall be cut off from the decking samples, after testing in the laboratory. Optionally, they may be cut off and prepared by provider (pending question)

Ref.	t_N
TT-3-090-1	0.90
TT-3-090-2	0.90
TT-3-090-3	0.90
TT-3-090-4	0.90
TT-3-090-5	0.90
TT-3-090-1	1.20
TT-3-090-2	1.20
TT-3-090-3	1.20
TT-3-090-4	1.20
TT-3-090-5	1.20

Key (see Fig. 2.2.1, plate coupons)
L = 200 mm (total length)
L_c = 100 mm (parallel length)
L_0 =80 mm (initial gauge length)
b = 30 mm (total width)
b_0 = 20 mm (width of the parallel reduced part)