Technical Approval

SP The Technical Research Institute of Sweden (SP SITAC) hereby confirms that

Profiled steel sheeting TP128, TP200 with fire resistance R15-R60

has been deemed to fulfil the Swedish National Board of Housing Building and Planning (Boverket) building regulations (BBR) in accordance with and subject to the conditions specified in this certificate.

SITAC Approval Certificate

No. 0006/06

Date: 01/06/2012

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1) Holder

Areco Sweden AB, Corporate identity number: 556266-4515
Vinkelgatan 13, 211 24 Malmö, www.areco.se

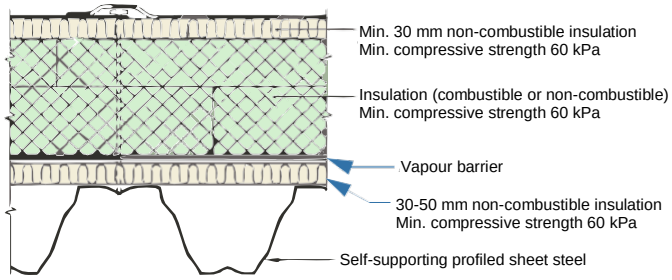
2) Manufacturer

Steel profiles TP128 TP200 S350GD+Z/AZ and S350GD+ZMA manufactured by Areco Sweden AB in Malmö

3) Product Description

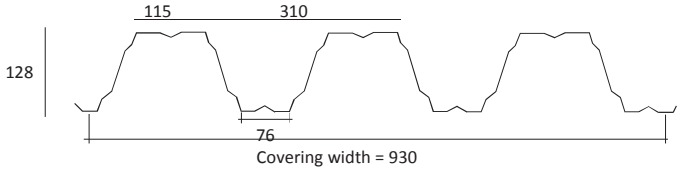
3.1 Construction system

The type approval covers the Areco construction system with self-supporting profiled sheet steel, where the roof structure must have documented fire resistance. The fundamental design of the roof structure is shown in **Figure 1**. The structure is assembled at the construction site.



3.2 Profiled Sheet Steel TP 128, TP200

The load-bearing steel sheets consist of standard trapezoidal profiled sheeting of type TP128 in accordance with **Figure 2**. The sheet thickness is between 0.70 mm and 1.5 mm and comprises S350GD+Z/ AZ and S350GD+ZMA grade cold-rolled steel. Its yield limit is a minimum of 350 mm^2.



Covering width = 854

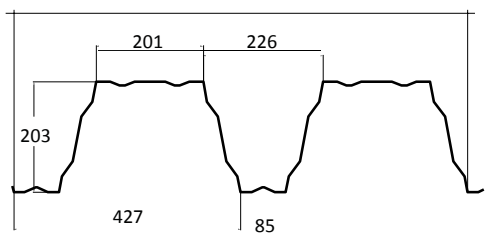


Fig. 2

The sheets can also be supplied with a 15 µm polyester coating or ZMA140 g/m2+ 25 µm polyester coating.

Fasteners

Steel sheeting is secured using galvanised steel fasteners. The following materials are used as part of the construction system

- *For the side overlap of the sheets*
  - Ø 4.8x20 self-tapping screws
  - Ø 5.5x20 self-tapping screws
  - Ø 6.3x20 self-tapping screws
- *For securing the sheets to steel supports*
  - Ø 5.5x30/40 self-tapping screws
  - Ø 4.5x19/20 impact nails
- *For securing the sheets to wooden supports*
  - Ø 6.5x51 self-tapping screws
- *For securing the sheets to concrete supports*
  - Ø D06-6.3x38 Spike
  - Ø 6.0x70 Concrete screws

When securing to materials other than steel, the pullout force from the supporting member must be calculated separately.

3.3 Insulation material

The insulation and vapour barrier are not supplied by Areco as part of the construction system. The design specified in point 6 as non-combustible insulation shall be of at least class A2-s1,d0 according to EN 13501-1.

4) Area of application

The Areco roof structure with a fire resistance of R15-R60 can be used on both flat and pitched roofs but should not be used for roofs on buildings containing a high degree of moisture (such as swimming baths) without a specific control of moisture safety.

5) Properties

5.1 Load-bearing

The cross-sectional data for the various TP128 and TP200 profiles are contained in Table 1. The values and calculations in the tables are based on materials data and sectional data specified in the Areco data sheets TP128 & TP200.

5.2

Table 2 Properties TP128 & TP200 when exposed to fire. The table shows the maximum evenly distributed load at ultimate limit state during a fire and with regard to the span. The calculations have been made taking account of EN 1991:2009, Actions on structures, Actions on structures exposed to fire and EN 1993:2005 General rules - Structural fire design.

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Table 1 - Areco TP128-350 Cross-sectional data

Sheet thickness, nominal	t_{nom}	mm	0.70	0.80	0.90	1.00	1.20
Sheet thickness, in calculation	t_{ber}	mm	0.665	0.760	0.866	0.955	1.144
Yield point	f_{ty}	N/mm2	350	350	350	350	350
Mass	m	kg/m	8.40	9.60	10.80	12.00	14.40
Dead weight incl. side overlap	g	kN/m2	0.090	0.103	0.116	0.129	0.155
Bearing resistance l_s=100 mm	R	kN/m	19.6	26	33.9	41.1	58.5
Narrow flange under pressure	M_d	kNm/m	11.95	14.05	16.41	19.09	25.5
2nd moment of area	I_{def}	mm4/mm	2486	2841	3238	3571	4277
Wide flange under pressure	M_d	kNm/m	9.51	11.71	14.30	16.56	21.18
2nd moment of area	I_{def}	mm4/mm	2410	2819	3238	3571	4277

Table 1 - Areco TP128-420 Cross-sectional data

Sheet thickness, nominal	t_{nom}	mm	0.70	0.80	0.90	1.00	1.20
Sheet thickness, in calculation	t_{ber}	mm	0.665	0.760	0.866	0.955	1.144
Yield point	f_{ty}	N/mm2	420	420	420	420	420
Mass	m	kg/m	8.40	9.60	10.80	12.00	14.40
Dead weight incl. side overlap	g	kN/m2	0.090	0.103	0.116	0.129	0.155
Bearing resistance l_s=100 mm	R	kN/m	21.60	28.50	37.10	45.10	64.10
Narrow flange under pressure	M_d	kNm/m	13.70	16.35	19.16	21.54	28.17
2nd moment of area	I_{def}	mm4/mm	2486	2841	3238	3570	4277
Wide flange under pressure	M_d	kNm/m	10.50	13.01	15.97	18.58	24.39
2nd moment of area	I_{def}	mm4/mm	2372	2774	3235	3570	4277

Table 1 - Areco TP200-350 Cross-sectional data

Sheet thickness, nominal	**t_{nom}**	**mm**	**0.70**	**0.80**	**0.90**	**1.00**	**1.20**	**1.50**
Sheet thickness, in calculation	t_{ber}	mm	0.665	0.760	0.866	0.955	1.144	1.42
Yield point	f_{ty}	N/mm2	350	350	350	350	350	350
Mass	m	kg/m	8.40	9.60	10.80	12.00	14.40	18.00
Dead weight incl. side overlap	g	kN/m2	0.098	0.112	0.126	0.141	0.169	0.211
Bearing narrow resistance l_s=100 mm	R	kN/m	13.00	17.50	23.20	28.50	41.10	62.80
Narrow flange under pressure	M_d	kNm/m	16.68	20.07	23.73	26.86	33.65	49.43
2nd moment of area	I_{def}	mm4/mm	6589	7560	8614	9499	11379	14125
Bearing wide resistance l_s=100 mm	R	kN/m	13.00	17.20	22.00	26.60	37.70	58.40
Wide flange under pressure	M_d	kNm/m	13.08	16.28	20.04	22.83	29.89	39.55
2nd moment of area	I_{def}	mm4/mm	6252	7194	8255	9155	11088	13954

Table 1 - Areco TP200-420 Cross-sectional data

Sheet thickness, nominal	**t_{nom}**	**mm**	**0.70**	**0.80**	**0.90**	**1.00**	**1.20**	**1.50**
Sheet thickness, in calculation	t_{ber}	mm	0.665	0.760	0.866	0.955	1.144	1.42
Yield point	f_{ty}	N/mm2	420	420	420	420	420	420
Mass	m	kg/m	8.40	9.60	10.80	12.00	14.40	18.00
Dead weight incl. side overlap	g	kN/m2	0.098	0.112	0.126	0.141	0.169	0.211
Bearing narrow resistance l_s=100 mm	R	kN/m	14.3	19.2	25.4	31.2	45.0	68.8
Narrow flange under pressure	M_d	kNm/m	18.91	23.11	27.45	31.17	39.22	52.67
2nd moment of area	I_{def}	mm4/mm	6572	7540	8614	9499	11379	14125
Bearing wide resistance l_s=100 mm	R	kN/m	14.3	18.9	24.1	29.1	41.3	64.0
Wide flange under pressure	M_d	kNm/m	14.79	18.41	22.75	26.02	33.11	45.94
2nd moment of area	I_{def}	mm4/mm	6225	7160	8214	9107	11026	13873

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Table 2 - Areco TP128-350 Capacity when exposed to fire

Thickness (mm)	Fire class	Capacity kN/m2											
		Span width (m)											
		4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.5
0.70	R15	7.23	6.75	6.33	5.95	5.62	5.33	5.06	4.82	4.60	4.40	4.22	4.05
0.70	R30	3.65	3.40	3.19	3.00	2.84	2.69	2.55	2.43	2.32	2.22	2.13	2.04
0.70	R60	2.18	2.04	1.91	1.80	1.70	1.61	1.53	1.46	1.39	1.33	1.27	1.22
0.80	R15	8.30	7.75	7.27	6.84	6.46	6.12	5.81	5.54	5.28	5.05	4.84	4.65
0.80	R30	4.17	3.90	3.65	3.44	3.25	3.08	2.92	2.78	2.66	2.54	2.44	2.34
0.80	R60	2.50	2.33	2.18	2.06	1.94	1.84	1.75	1.66	1.59	1.52	1.46	1.40
0.90	R15	9.52	8.88	8.33	7.84	7.40	7.01	6.66	6.34	6.06	5.79	5.55	5.33
0.90	R30	4.76	4.45	4.17	3.92	3.71	3.51	3.34	3.18	3.03	2.90	2.78	2.67
0.90	R60	2.85	2.66	2.49	2.34	2.21	2.10	1.99	1.90	1.81	1.73	1.66	1.59
1.00	R15	10.54	9.84	9.23	8.68	8.20	7.77	7.38	7.03	6.71	6.42	6.15	5.90
1.00	R30	5.26	4.91	4.60	4.33	4.09	3.88	3.68	3.51	3.35	3.20	3.07	2.95
1.00	R60	3.14	2.93	2.75	2.59	2.44	2.31	2.20	2.09	2.00	1.91	1.83	1.76
1.20	R15	12.76	11.91	11.17	10.51	9.93	9.41	8.93	8.51	8.12	7.77	7.45	7.15
1.20	R30	6.32	5.90	5.53	5.21	4.92	4.66	4.42	4.21	4.02	3.85	3.69	3.54
1.20	R60	3.76	3.51	3.29	3.10	2.93	2.77	2.63	2.51	2.40	2.29	2.20	2.11

Table 2 - Areco TP128-420 Capacity when exposed to fire

Thickness (mm)	Fire class	Capacity kN/m2											
		Span width (m)											
		4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.5
0.70	R15	8.68	8.10	7.59	7.15	6.75	6.39	6.07	5.78	5.52	5.28	5.06	4.86
0.70	R30	4.38	4.09	3.83	3.60	3.40	3.23	3.06	2.92	2.79	2.66	2.55	2.45
0.70	R60	2.62	2.45	2.29	2.16	2.04	1.93	1.83	1.75	1.67	1.60	1.53	1.47
0.80	R15	9.97	9.30	8.72	8.21	7.75	7.34	6.98	6.64	6.34	6.07	5.81	5.58
0.80	R30	5.01	4.68	4.38	4.13	3.90	3.69	3.51	3.34	3.19	3.05	2.92	2.81
0.80	R60	3.00	2.80	2.62	2.47	2.33	2.21	2.10	2.0	1.91	1.82	1.75	1.68
0.90	R15	11.42	10.66	9.99	9.40	8.88	8.41	7.99	7.61	7.27	6.95	6.66	6.39
0.90	R30	5.72	5.34	5.0	4.71	4.45	4.21	4.00	3.81	3.64	3.48	3.34	3.20
0.90	R60	3.42	3.19	2.99	2.81	2.66	2.52	2.39	2.28	2.17	2.08	1.99	1.91
1.00	R15	12.65	11.81	11.07	10.42	9.84	9.32	8.86	8.43	8.05	7.70	7.38	7.09
1.00	R30	6.31	5.89	5.52	5.20	4.91	4.65	4.42	4.21	4.02	3.84	3.68	3.54
1.00	R60	3.77	3.52	3.30	3.10	2.93	2.78	2.64	2.51	2.40	2.29	2.20	2.11
1.20	R15	15.32	14.30	13.40	12.61	11.91	11.29	10.72	10.21	9.75	9.32	8.93	8.58
1.20	R30	7.59	7.08	6.64	6.25	5.90	5.59	5.31	5.06	4.83	4.62	4.42	4.25
1.20	R60	4.52	4.22	3.95	3.72	3.51	3.33	3.16	3.01	2.87	2.75	2.63	2.53

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Table 2 - Areco TP200-350 Capacity when exposed to fire

Thickness (mm)	Fire class	Capacity kN/m2											
		Span width (m)											
		4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.5
0.70	R15	10.94	10.21	9.57	9.01	8.51	8.06	7.65	7.29	6.96	6.66	6.38	6.12
0.70	R30	5.52	5.15	4.83	4.54	4.29	4.06	3.86	3.68	3.51	3.36	3.22	3.09
0.70	R60	3.30	3.08	2.89	2.72	2.57	2.43	2.31	2.20	2.10	2.01	1.93	1.85
0.80	R15	12.56	11.72	10.99	10.34	9.77	9.25	8.79	8.37	7.99	7.64	7.33	7.03
0.80	R30	6.31	5.89	5.52	5.20	4.91	4.65	4.42	4.21	4.02	3.84	3.68	3.54
0.80	R60	3.78	3.52	3.30	3.11	2.94	2.78	2.64	2.52	2.40	2.30	2.20	2.11
0.90	R15	14.39	13.43	12.59	11.85	11.19	10.60	10.07	9.59	9.16	8.76	8.39	8.06
0.90	R30	7.21	6.72	6.30	5.93	5.60	5.31	5.04	4.80	4.59	4.39	4.20	4.03
0.90	R60	4.30	4.02	3.77	3.54	3.35	3.17	3.01	2.87	2.74	2.62	2.51	2.41
1.00	R15	15.95	14.88	13.95	13.13	12.40	11.75	11.16	10.63	10.15	9.71	9.30	8.93
1.00	R30	7.96	7.43	6.96	6.55	6.19	5.86	5.57	5.30	5.06	4.84	4.64	4.46
1.00	R60	4.75	4.43	4.15	3.91	3.69	3.50	3.32	3.17	3.02	2.89	2.77	2.66
1.20	R15	19.30	18.02	16.89	15.90	15.01	14.22	13.51	12.87	12.28	11.75	11.26	10.81
1.20	R30	9.56	8.92	8.36	7.87	7.44	7.04	6.69	6.37	6.08	5.82	5.58	5.35
1.20	R60	5.69	5.31	4.98	4.69	4.43	4.19	3.98	3.79	3.62	3.46	3.32	3.19
1.50	R15	24.37	22.75	21.33	20.07	18.96	17.96	17.06	16.25	15.51	14.84	14.22	13.65
1.50	R30	11.92	11.12	10.43	9.81	9.27	8.78	8.34	7.94	7.58	7.25	6.95	6.67
1.50	R60	7.07	6.60	6.19	5.82	5.50	5.21	4.95	4.72	4.50	4.31	4.13	3.96

Table 2 - Areco TP200-420 Capacity when exposed to fire

Thickness (mm)	Fire class	Capacity kN/m2											
		Span width (m)											
		4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.5
0.70	R15	13.12	12.25	11.48	10.81	10.21	9.67	9.19	8.75	8.35	7.99	7.65	7.35
0.70	R30	6.62	6.18	5.79	5.45	5.15	4.88	4.63	4.41	4.21	4.03	3.86	3.71
0.70	R60	3.96	3.70	3.47	3.26	3.08	2.92	2.77	2.64	2.52	2.41	2.31	2.22
0.80	R15	15.07	14.07	13.19	12.41	11.72	11.10	10.55	10.05	9.59	9.17	8.79	8.44
0.80	R30	7.58	7.07	6.63	6.24	5.89	5.58	5.30	5.05	4.82	4.61	4.42	4.24
0.80	R60	4.53	4.23	3.96	3.73	3.52	3.34	3.17	3.02	2.88	2.76	2.64	2.54
0.90	R15	17.27	16.12	15.11	14.22	13.43	12.72	12.09	11.51	10.99	10.51	10.07	9.67
0.90	R30	8.65	8.07	7.57	7.12	6.72	6.37	6.05	5.76	5.50	5.26	5.04	4.84
0.90	R60	5.17	4.82	4.52	4.25	4.02	3.81	3.62	3.44	3.29	3.14	3.01	2.89
1.00	R15	19.13	17.86	16.74	15.76	14.88	14.10	13.39	12.76	12.18	11.65	11.16	10.72
1.00	R30	9.55	8.91	8.35	7.86	7.43	7.04	6.68	6.37	6.08	5.81	5.57	5.35
1.00	R60	5.70	5.32	4.99	4.69	4.43	4.20	3.99	3.80	3.63	3.47	3.32	3.19
1.20	R15	23.16	21.62	20.27	19.08	18.02	17.07	16.21	15.44	14.74	14.10	13.51	12.97
1.20	R30	11.47	10.71	10.04	9.45	8.92	8.45	8.03	7.65	7.30	6.98	6.69	6.42
1.20	R60	6.83	6.38	5.98	5.63	5.31	5.03	4.78	4.55	4.35	4.16	3.98	3.83
1.50	R15	29.25	22.75	25.59	24.09	22.75	21.55	20.47	19.50	18.61	17.80	17.06	16.38
1.50	R30	14.30	11.12	12.51	11.78	11.12	10.54	10.01	9.53	9.10	8.70	8.34	8.01
1.50	R60	8.49	6.60	7.43	6.99	6.60	6.25	5.94	5.66	5.40	5.17	4.95	4.75

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Table 3 - Areco TP128-350

Horizontal forces for different thicknesses for R15-R60

Thickness (mm)	Fire resistance	Horizontal Force kN
0.70	R15	66.12
0.70	R30	31.16
0.70	R60	17.59
0.80	R15	75.98
0.80	R30	35.66
0.80	R60	20.11
0.90	R15	87.12
0.90	R30	40.71
0.90	R60	22.93
1.00	R15	96.59
1.00	R30	44.97
1.00	R60	25.29
1.20	R15	117.08
1.20	R30	54.04
1.20	R60	30.32

Table 3 - Areco TP200-350
Horizontal forces for different thicknesses for R15-R60

Thickness (mm)	Fire resistance	Horizontal Force kN
0.70	R15	99.99
0.70	R30	47.12
0.70	R60	26.60
0.80	R15	114.91
0.80	R30	53.94
0.80	R60	30.41
0.90	R15	131.75
0.90	R30	61.57
0.90	R60	34.67
1.00	R15	146.07
1.00	R30	68.00
1.00	R60	38.25
1.20	R15	177.07
1.20	R30	81.73
1.20	R60	45.86
1.50	R15	224.08
1.50	R30	101.94
1.50	R60	56.99

Table 3 - Areco TP128-420

Horizontal forces for different thicknesses for R15-R60

Thickness (mm)	Fire resistance	Horizontal Force kN
0.70	R15	79.34
0.70	R30	37.39
0.70	R60	21.11
0.80	R15	91.18
0.80	R30	42.80
0.80	R60	24.13
0.90	R15	104.54
0.90	R30	48.86
0.90	R60	27.51
1.00	R15	115.91
1.00	R30	53.96
1.00	R60	30.35
1.20	R15	140.50
1.20	R30	64.85
1.20	R60	36.39

Table 3 - Areco TP200-420
Horizontal forces for different thicknesses for R15-R60

Thickness (mm)	Fire resistance	Horizontal Force kN
0.70	R15	119.99
0.70	R30	56.54
0.70	R60	31.92
0.80	R15	137.89
0.80	R30	64.72
0.80	R60	36.50
0.90	R15	158.10
0.90	R30	73.88
0.90	R60	41.61
1.00	R15	175.29
1.00	R30	81.60
1.00	R60	45.90
1.20	R15	212.48
1.20	R30	98.07
1.20	R60	55.03
1.50	R15	268.89
1.50	R30	122.33
1.50	R60	68.39

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The temperature in the sheet is calculated using the standard temperature – time set out in EN 1991-1-2:2002. It is assumed that the sheeting can absorb shear forces using the rope effect, see **Figure 3**, and that the joints and fasteners can transfer these forces.

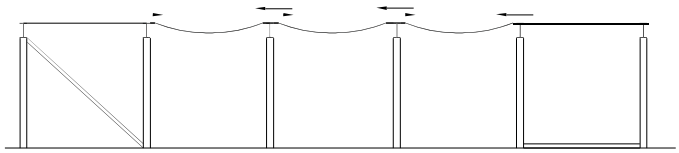
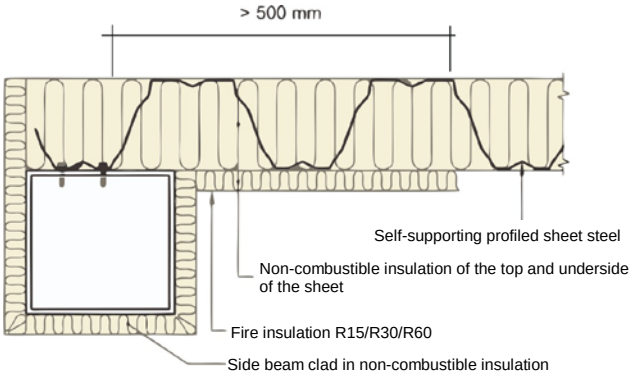
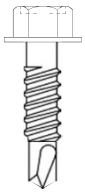


Fig. 3 Schematic diagram of membrane forces (rope effect)



5.4 The capacity of fasteners



The capacity of fasteners per lm (Sd) of sheeting is assumed to be:

Fire resistance corresponding to R15: $S_{dR15}=S_{d0} * 0.2$

Fire resistance corresponding to R30: $S_{dR30}=S_{d0} * 0.1$

Fire resistance corresponding to R60: $S_{dR60}=S_{d0} * 0.06$

Where S_{d0} is the capacity of the fasteners per lm of sheeting at normal room temperature as stated by the manufacturer of the fasteners.

The above instructions take into consideration that the sheeting is unprotected against fire from below. When the roof beams, side beams and roof sheeting are protected against fire according to **Figure 4**, it can be assumed that the fasteners retain their stated capacity at room temperature.

Rules for implementation

6.1 Project planning of roof sheeting

Every object in an Areco roof structure with fire resistance R15-R60 must be calculated and designed by Tunnplåts Konstruktion i Sverige AB. Including fasteners and joints. Special capacity calculations must be made for roof sheeting that extends more than 1/6th (but no more than 1 m).

Capacity and deformation are to be calculated with respect to EN 1993-1-2:2005, with the loads contained in EN 1991:2009 with a deformation limit of l/200. The roof structure may be used for bracing using rigid sheets.

The following checks and calculations are to be carried out prior to every project:

Checks to ensure that roof load does not exceed the values in tables 2-3, and that the load at the ends and intermediate supports do not exceed the capacity for the sheet given in Areco data sheet TP 128, TP 200. Alternately, specific calculations regarding this are to be made.

- The design for securing the sheeting with regard to wind load
- The design of of large overhangs
- The design of any diaphragm action in the sheet and associated fasteners
- The design of end bay sheets and connecting structural components to absorb the rope effect occurring during fires due to sagging
- The design of joining components in the event of accidental fires.
- When making all calculations, consideration must be taken of the criteria for the main structure

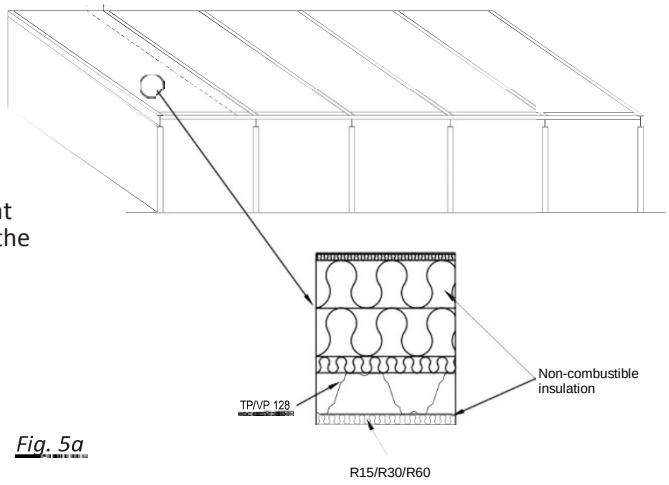


Fig. 5a

Technical Approval

- End bays and connecting structural components are to be designed so that they can absorb the rope effect by:
- Providing the steel plates and roof trusses in the end bays with fire protection see **Figure 5a**
- Fire insulation is to be non-combustible. It is to be installed in one or more layers. Insulation shall reach a minimum of 500 mm past the end bays.

Wind trusses in the roof in the end bays are to be provided with fire protection, see **Figure 5b**. Fire insulation of the trusses is to be carried out in accordance with EN 1993-1-2:2005. Anchor to a neighbouring building if possible.

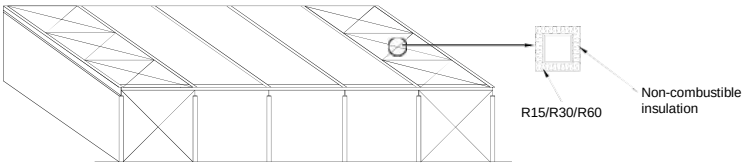
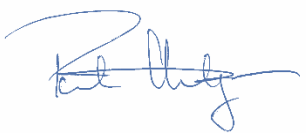


Fig. 5b

Malmö, 30 May 2018



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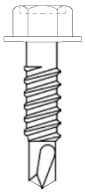
Areco Profiles AB

6.2 Design of fasteners

Design of the fasteners is to be in accordance with the following rules for anchoring the end bays, side laps and sheet joints over supports to transfer twisting forces.



Fasteners must be designed to manage the pullout forces that arise. Fractures at the edge of holes are to be prevented by ensuring that fasteners have excess capacity.

The fixing capacity per meter of width must be greater than the forces arising from the rope effect.

The rope effect principle can be simplified as $S_f = \sum Q_f \times l$ where $\sum Q_f$ are design loads and l = the span of the sheet.