RABLE

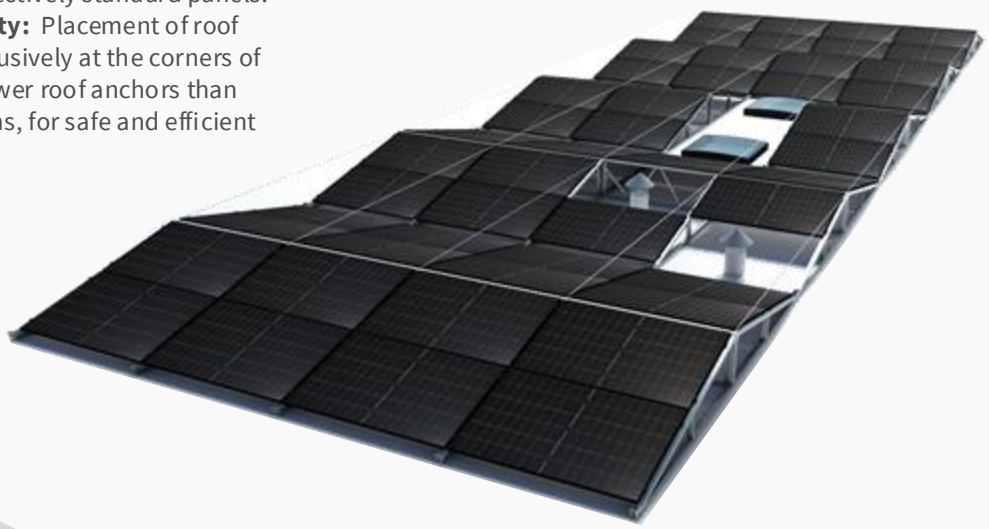
Unlocking the solar energy potential of all roofs

SOLARSOLUTIONS INTERNATIONAL
WINNAAR
BEST INNOVATION AWARD
2024

RABLE4Roofs

Ballastfree Mountingsystem

- **Innovative Truss Principle:** Unique ballast-free and self-supporting system due to advanced truss principle.
- **Maximumspan:** Suitable for roofs with constructive limitations , where distance between loadbearing roof beams spans up to 25 meters.
- **Equal Weight Distribution:** Each point carries equal load, from 7 kg/m² to 13 kg/m² for lightweight respectively standard panels.
- **Stability& Scalability:** Placement of roof anchors almost exclusively at the corners of a field, up to 95% fewer roof anchors than conventional systems, for safe and efficient installation.



Relevant norms

NEN 1010

All-metal construction with excellent grounding & bonding

NEN 7250

Supplied in accordance with force standards based on **Eurocodes**.

SCOPE 12

RABLE installations have been inspected and approved by SCOPE 12 inspectors

15 years
Guarantee

Full Specs

Technical Specifications RABLE4roofs and RABLE8roofs

General

Roof type:	Flat roofs, max. slope 10°
Material:	Magnelis galvanized steel
System width:	Panel length +24mm
Panels:	Universal application
Configuration:	East-West
System tilt angle	12,5°

	RABLE4Roofs	RABLE8Roofs
Panels per system	4	8
System length (mm)	4800	9500
Max. span (m)	10	25

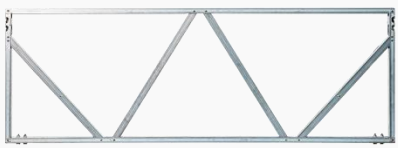
Unique Truss Principle

Using the patented steel cable, a truss is formed in the longitudinal direction. The central rear frame forms a truss in the lateral direction. These two trusses over two axes create an extremely rigid structure.

The steel cable creates bending resistance in the longitudinal direction, enabling significant spans of up to 25 meters. The rigid construction ensures an even weight distribution across the entire field, supporting the beams and trusses of the roof. The truss structure not only provides efficient load-bearing capacity but also minimizes the load on the roof panels, making the system suitable for roofs where no additional load on the roof panels is possible.

- The weight of the substructure is a maximum of 3 kg/m²
- Maximum roof load is 7 kg/m² with lightweight panels, or 13 kg/m² with regular panels
- Suitable for roofs where roof panels may fail
- For advice on allowable roof load, contact RABLE

Expandable Side



Customized Center

Cable

Windtunneltest

TU Delft conducted wind tunnel studies on behalf of RABLE Group B.V. in accordance with CUR recommendation 103.

The results have been incorporated by RABLE Group B.V. into calculation tables for the design of layout and anchor plans for PV installations, in compliance with NEN 7250 and Eurocodes.

The wind tunnel tests were conducted to gain insight into the loads on the mounting structure under various weather conditions. The study, simulations, and analyses showed that RABLE can significantly reduce the number of roof anchors (up to 95% fewer than anchored systems) without compromising the stability and safety of the structure. This results in a more cost-effective solution while also reducing the risk of roof damage and leakage.

Expert Report

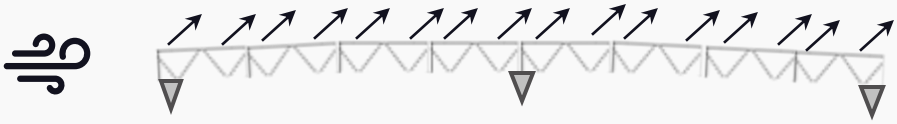
Anchor Plan Explanation

Based on the wind tunnel tests, the lift coefficient of the RABLE substructure has been determined. Using this coefficient and the maximum dynamic pressure— which depends on factors such as building height, wind zone, and building density—the upward force on the system is calculated.

The strength and stiffness of the RABLE substructure have been determined using the Finite Element Method (FEM). In combination with this stiffness and strength, as well as the upward force (dependent on the previously mentioned factors), the number and position of the anchors are determined. A maximum anchor force of 150 kg per anchor is assumed.

Wind Zone 3 | Built-up area | Low building

Wind zone 1 | Unbuilt area | High building



NEN 1010

Measurement No.	First measuring point	Second measuring point	Length of the route (estimated)	Resistance	Abnormality
1	Measuring point substructure	Measuring point substructure	2,00 meter	0,03 Ohm	No
2	Measuring point substructure	Measuring point substructure	4,00 meter	0,03 Ohm	No
3	Measuring point substructure	Measuring point substructure	6,00 meter	0,04 Ohm	No
4	Measuring point substructure	Measuring point substructure	1,00 meter	0,07 Ohm	No

Inspection SCIOS V2.0 | 21-04-2023 | Chris van Emmerik
12996 SCOPE 12 RABLE-structure Inspection Report

omega inspectie

SCOPE 12 Inspection DBD

Load capacity

The load-bearing capacity of the building's structure is insufficient to support a conventional solar power system held in place by ballast. By using this newly developed mounting structure, no ballast is required to keep the system in place. The entire (pilot) system is fixed at the four corners to the structure. According to the structural calculations, all weights remain within the margins of what the structure could additionally support.

Conclusion

It is an innovative installation with potential to be widely applied. worden.

Corrosion Magnelis

RI. SE

Type Approval and decision on production control
SC0559-13

Steel flat products for cold forming coated with Magnelis® ZM310

Holder/Issued to

ArcelorMittal Europe - Flat Products
1160 LUXEMBOURG, LUXEMBOURG

Product description

Steel flat products for cold forming coated with Magnelis® ZM310. Products are manufactured in accordance with EN 10346:2015 with steel grades as specified in table 1, table 2 and table 3 of the standard. Magnelis® ZM310 is a corrosion protective alloyed coating composed of zinc, aluminium and magnesium.

Intended use

Products and structures manufactured from steel flat products for indoor- and outdoor applications. Products coated with Magnelis® ZM310 are suitable for corrosivity category C5, according to in SS-EN ISO 12944-2 described class, based on a deemed expected lifetime of 15 years.

Corrosion Magnelis

thyssenkrupp

thyssenkrupp Materials (UK) Ltd

Aluminium Alloy 6005A - T6 Extrusion — Material Data Sheet

Specifications

- Commercial: 6005A
- EN: 6005A

Aluminium alloy 6005A is a medium strength, heat treatable alloy with excellent corrosion resistance. Alloy 6005 has properties between those of alloys 6061 and 6082and can sometimeabe used interchangeably with these alloys, but 6005 has better extrusion characteristics and a better mill surface finish. It is difficult to produce thin-wall or complicated extrusions in 6005, but it is still more extrudable than 6082. 6005A tube has very good bending properties.

Application

6005 and 6005A typically find application in intricate extrusions like: tubing for furniture, railway and bus profile structures, pylons, platforms and pipelines, portable ladders and sections where greater strength is needed than given by 6060 and 6063.

Hotspot impact

RABLE measured the potential hotspot impact of the cable by applying two methods: direct temperature measurements and the use of a thermal camera.

The measurement conditions on the sunny midday of September 1, 2022, without cloud cover, indicated a temperature difference of 0.7°C between the shaded part of the panel and the panel cable, which is not detrimental to the panel's performance in the short or long term.

Figure 1 shows thermal images of the solar panels, including the shadow of the steel cable. As seen in the pictures, no hotspots are present.

Figure 1: Illustration of the RABLE test rig including thermal camera

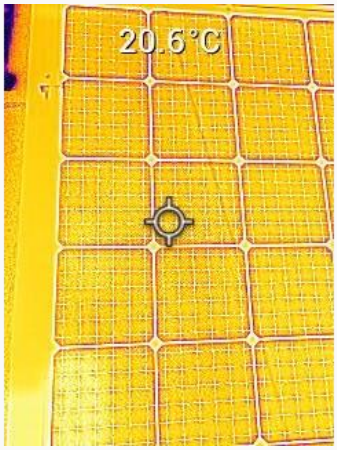


Figure 2: Photo from the thermal camera

Figure 3: Temperature measurement of a section of a PV cell in the shadow, with infrared laser thermometer

Figure 4: Temperature measurement of a section of a PV cell in the sun, with an infrared laser thermometer

Figures 3 and 4 show the difference in temperature between the direct and indirect (shadow) sunlight. This temperature difference is 0.7 °C. The measurements took place on September 1, 2022 at 13:00.

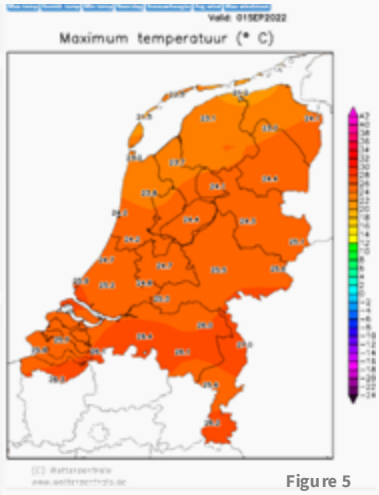


Figure 5

Figure 5 shows the outdoor temperature on September 1, 2022, and displays the temperatures in the Netherlands during the measurements. In Figure 6, it can be seen that the surrounding roof surface exceeds a temperature of 40 degrees during the measurements.

In conclusion, the thermal imaging and temperature measurements of the shadow caused by the steel cable **show no adverse effects** on the panel's performance in the short or long term.

Project specific special

Mounting on an exoskeleton

In addition to mounting on flat roofs, the RABLE mounting system is perfectly suited for use on an exoskeleton. This includes installing solar panels on canopies of gas stations or above air handling units on the roof.

Mounting on a roof with height differences

With the use of a minimal number of support legs, it is also possible with RABLE to accommodate height differences on various roof surfaces. In this way, despite the height differences, the roof surface can be optimally utilized with solar panels.

Aesthetic solutions

In a nearby project, the RABLE8Roofs system has been elevated. This has aligned the panels with the four roof ridges, according to the architect's vision.