WIND RESISTANT

Watertight
Wind Resistant
Sound absorbing
Lightweight
Fast to install
Easy to install
Aesthetic
Eco-responsible

To sum up all the arguments, what makes ONDULINE® resistant to strong winds?

- A **unique fixation system with washer of 16 mm minimum** (standards on the market have a diameter of 14 mm or less).
- A **minimum of 10 fixations per m².**
- ONDULINE® sheets have a corrugated shape, which increases their rigidity and stability.
- ONDULINE® sheets are flexible and resilient, which allows them to absorb shocks and vibrations caused by wind gusts.
- They come with matching accessories **that do not let the wind pass through the sheets.**

⟶ Thanks to this, ONDULINE® CLASSIC sheets can resist to high winds, up to 225 km/h when installed on metal structure, and up to 260 km/h when installed on wooden purlins. ONDUVILLA® can resist up to a wind speed of 315 km/h when installed on metal structure, and up to 290 km/h when installed on wooden purlins.

What is the resistance capacity of ONDULINE® sheets to strong winds?

- **ONDULINE® CLASSIC** sheets can justify a very strong resistance to high winds, **up to 225 km/h** when installed on metal structure, and **up to 260 km/h** when installed on wooden purlins. It makes of it a particular **clever choice for coastal areas, areas subject to typhoons** and where buildings are particularly exposed.

Installed on metallic purlins
Onduline® Classic supports winds up to 3000 Pascal, **> 225 km/h**

Belgian Building Research Institute (BBRI) – Wind uplift test on roof waterproofing – Ref: DE 651XM223, CAR 15070/1 (29) - 2015

Installed on wooden purlins
Onduline® Classic supports winds up to 4000 Pascal, **> 260 km/h**

Belgian Building Research Institute (BBRI) – Wind uplift test on roof waterproofing – Ref: DE 651XM223, CAR 15070/2 (29) - 2015

- **ONDUVILLA®** can resist **up to a wind speed of 315 km/h** when installed on metal structure, and **up to 290 km/h** when installed on wooden purlins.
(This higher resistance is due to the number of fixations).

Products tested: CLASSIC + ONDUVILLA® with universal screws**. Any other installation configuration cannot refer to these tests.**
Ex: ONDUVILLA® installed with other fixings.

⟶ Belgian Building Research Institute (BBRI) – Wind uplift test on roof waterproofing:

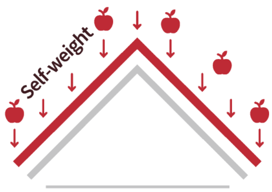
- DE 651XM223 CAR 15070/1 (29) = ONDULINE® CLASSIC Metal Purlin = 3000Pa (225 km/h)
- DE 651XM223 CAR 15070/2 (29) = ONDULINE® CLASSIC Wood Purlin = 4000Pa (260 km/h)

- DE 651XL019 CAR 13222/1 (85) = ONDUVILLA® Metal Purlin = 6000Pa (315 km/h)
- DE 651XL019 CAR 13222/2 (85) = ONDUVILLA® Wood Purlin = 5000Pa (290 km/h)

Did you know?

1) Performance-based wind engineering (PBWE) is an ever-growing research field. The significant wind-related economic losses incurred every year around the world have prompted researchers to develop methods to reframe wind engineering.

2) Wind load is one of the significant action on roofs. There is also **the load of self-weight materials.**



3) Several ONG favourised ONDULINE® over traditional metal roof to build new shelters after floods (Malawi) and earthquake (Haiti).

No rights for pictures use.

Testimonial ONG report Haiti , p18 (2011):

*"The use of Onduline corrugated bituminous roofing meets the project requirements in a number of respects. This type of roofing has several advantages over the traditional corrugated metal roofing as the sheets are lighter, easier to transport and install, less expensive, provide greater insulation and are not as sharp, being thus **less of an accident risk during high winds.** This final point was particularly highlighted by the authorities, especially the DPC, who underlined that cuts from steel roofing sheets are one of the most common causes of injury during storms".*

Onduline
Lightweight roofing systems

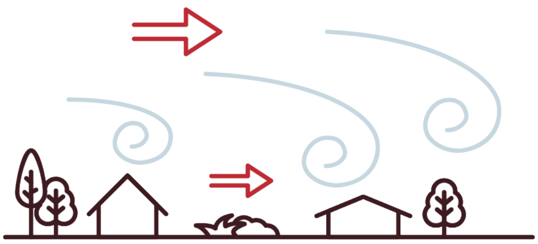
MORE FAQ ABOUT WIND RESISTANT

How is wind formed?

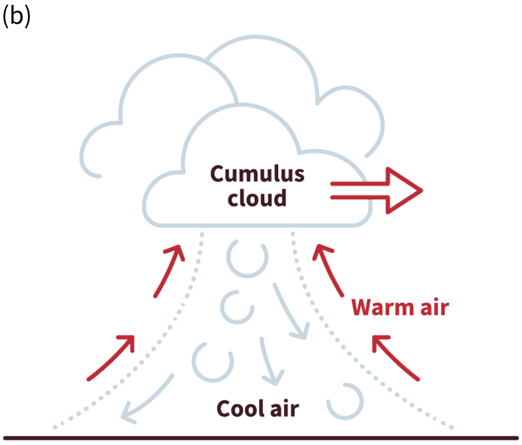
Wind is air movement relative to the Earth, driven by several different forces, especially pressure differences in the atmosphere, which are themselves produced by differential solar heating of different parts of the Earth's surface, and forces generated by the rotation of the Earth. The differences in radiation between the poles and the Equator, produce temperature and pressure differences. These together with the effects of the Earth's rotation set up large-scale circulation systems in the atmosphere, with both horizontal and vertical orientations. The result of these circulations is that the prevailing wind directions in the tropics, and near the poles, tend to be easterly. Westerly winds dominates in the temperature latitudes.

Local severe winds may also originate from local convective effects *(thunderstorms)*, or from the uplift of air masses produced by mountain ranges (*downslope winds*). Severe tropical cyclones, known in some parts of the world as *hurricanes* or *typhoons*, generate extremely strong winds over some parts of the tropical oceans and coastal regions, in latitudes from 10 to about 30°C, both north and south of the Equator *(Holmes, 3rd edition, 2015).*

(a)



(b)



The generation of turbulence in (a) boundary-layer winds and, (b) thunderstorm downdrafts.

What is wind load on a roof?

Wind load can have a significant impact on a roof and its overall structural integrity. When wind blows over a building**, it creates a force that exerts pressure on the roof surface.** This pressure is known as wind load, and it can cause the roof to experience various types of stress, such as uplift, suction, and shearing forces.

Uplift load

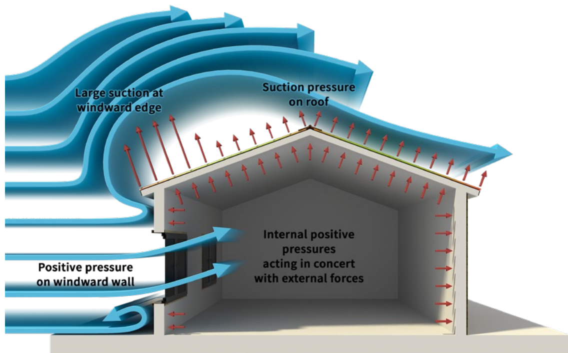
Uplift is the most common type of stress caused by wind load. It occurs when the wind blows over the surface of the roof and creates a vacuum effect that lifts the roofing materials upward. This force can be particularly strong near the edges of the roof, where the wind can get underneath and create a lifting effect.

Suction force is another type of stress that can affect a roof due to wind load. This occurs when the wind blows over the roof and creates a low-pressure zone that can suck the roofing materials downward. This force can be particularly strong near the edges of the roof, where the wind can create a negative pressure zone. If the suction force is strong enough, it can cause the roofing materials to become dislodged or even break.

Suction force

Shear load

Shearing forces are created when the wind blows over a sloping roof and creates a horizontal force that can push against the roof structure. This force can be particularly strong near the peak of the roof, where the wind can create a shear effect. If the shearing force is strong enough, it can cause the roof structure to buckle or even collapse.



Positive internal pressure: when wind blows into an open-sided building or through a large door, the internal pressure seeks to force the roof and side coverings outwards, resulting in positive internal pressure.

Negative internal pressure (suction): this is formed within a building when the wind blows in the opposite direction, tending to pull the roof and side coverings inwards.

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Lightweight roofing systems

MORE FAQ ABOUT WIND RESISTANT

How to prevent wind load from damaging a roof?

To prevent wind load from damaging a roof, it is important to ensure that the roof is designed and constructed to withstand the forces that can be created by the wind. By using **strong fasteners** and providing **adequate anchorage at the edges of the roof** you minimise the risk of wind damage.

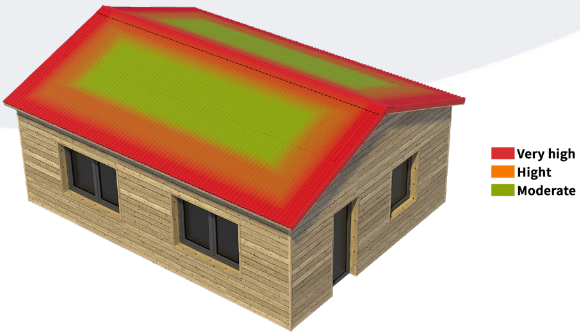
Fasteners play a crucial role in the installation. Here are some reasons why fasteners are important when installing a bitumen sheet roof:

1-Wind Resistance: Fasteners prevent sheets from being blown off in strong winds

2-Durability: Properly installed fasteners ensure long-term roof durability.

3-Watertightness: Fasteners help seal the sheets and prevent water leaks.

4-Aesthetics: Properly installed fasteners help maintain a neat and uniform appearance of the roof.



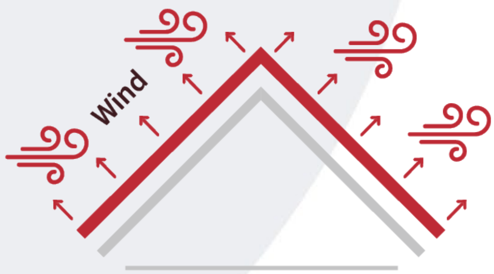
Simplified representation of wind load on pitched roof

Where roof pitch is less than 10°, there is no increase for ridge and hips *(Laurin Dominik, 2022).*

What makes ONDULINE® sheets special is **their unique and patented fixation system.** It allows to create a mechanical bond between the sheet and the support, which **prevents the roof from being lifted** by the wind pressure and to resist even to the strongest winds.

How to calculate wind load on a roof?

Here we will not enter into too many details but give a general overview of the important parameters. For more details, check the article of *Laurin Dominik, **How to calculate wind load on a pitch roof?** (2022) and Ubani Obinna, dynamic civil engineer and researcher, **How to apply wind load on roofs of buildings** (2022).*



The method for the application of wind load on roofs is given in **EN 1991-1-4:2005** (Eurocode 1 Part 4). The effect of wind on any structure (i.e. the response of the structure); depends on many variables. These control parameters include, among several others, (i) external pressure dominant parameters: roof shape, roof pitch, eave shape, building geometry, presence of canopy or parapet, and the surrounding buildings (He et al., 2017); (ii) internal pressure dominant parameters: building opening(s) (size and location, number of openings) (Kopp et al., 2008), and the overall flexibility of the structure (Sharma and Richards, 2003; Guha et al., 2011); (iii) wind field control parameters: terrain exposure, wind speed and direction, etc.

It is important to note that the wind actions calculated by using EN 1991-1-4: 2005 are characteristic values and are determined from the basic values of wind velocity or velocity pressure. Unless otherwise specified, wind actions are classified as variable fixed actions.

EN 1991-1-4: Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions (phd.eng.br)

5.3 Wind forces

(1) The wind forces for the whole structure or a structural component should be determined:

by calculating forces using force coefficients (see (2)) or

by calculating forces from surface pressures (see (3))

(2) The wind force F_w acting on a structure or a structural component may be determined directly by using Expression (5.3)

$$F_w = c_s c_d \cdot c_f \cdot q_p(z_e) \cdot A_{ref} \quad (5.3)$$

or by vectorial summation over the individual structural elements (as shown in 7.2.2) by using Expression (5.4)

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FOCUS ON TYPHOONS/HURRICANES

What does the UK meteorological office say about high winds?

All buildings should be constructed so that they can safely resist the strongest winds likely to be encountered. In tropical regions, these conditions arise during windstorms called cyclones, hurricanes or typhoons, depending on the area of the world in which the storm occurs.

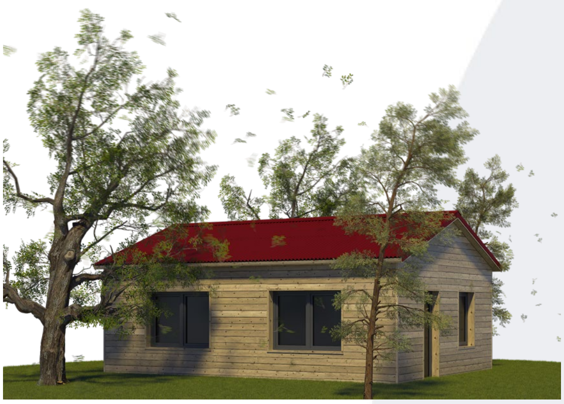
The forces exerted on the various elements of a building during a cyclone act in different directions relative to the wind direction and are proportional to the square of the wind speed, e.g. **if the wind speed increases from 126 km/h to 252 km/h, the wind forces increase by four times** (*UK meteorological office*).

What is the difference between typhoon and hurricane?

If it's above the North Atlantic, central North Pacific or eastern North Pacific oceans (Florida, Caribbean Islands, Texas, Hawaii, etc.), we call it a hurricane. If it hovers over the Northwest Pacific Ocean (usually East Asia), we call it a typhoon.

What happens with wind forces when a typhoon/hurricane occur?

High-intensity wind events such as hurricanes generate vortices-induced fluid-structure interaction that are typically associated with high suction pressures leading to strong uplift forces exerted on the roof (Holmes, 2015). " The large number of factors that controls the RTWC (roof to wall connections for residential buildings) uplift forces during windstorms significantly increases the uncertainties inherent inaccurate estimation of these forces and hence hinders achieving safer low-rise residential communities " (Holmes, 2020).



Can ONDULINE® sheets resist typhoons/hurricanes?

To date, we do not have any scientific nor technical test that validate this claim. Tests are difficult to set up and be carried out. There are only a few specialised bodies.

So what can we say?

We do not risk it by saying that ONDULINE® sheets have proven their reliability in all regions of the world exposed to high winds and are particularly suitable for coastal areas. Also, they are quite popular in regions where typhoons can occur.

When using this argument, avoid too assertive tone, prefer expressions such as « Based on our local experience... ».

We have testimonials we can refer to in different countries about the resistance to typhoons/hurricanes.

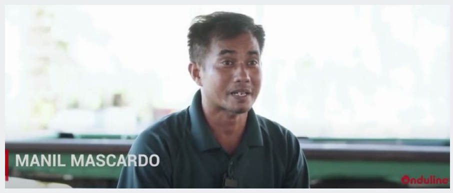
Resilience after typhoon Odette, Siargao, Philippines (2021).

The landfall of the typhoon Odette or Rai started in Siargao, Philippines, category 5, a super typhoon with winds of at least 240km/h (150 mph) as per JTWC (Joint Typhoon Warning Center).

- Maximum sustained winds – 195 km/h
- Gustiness – 260 km/h

Video:

https://www.youtube.com/watch?v=EAVp9jw1ejU&t=13s



Written testimonials:

https://ph.onduline.com/en/homeowner/inspiration/testimonials/architect-1

https://ph.onduline.com/en/homeowner/inspiration/testimonials

→ **Take away for the audience:** *"If Onduline sheets have withstood a typhoon, they can without any doubt withstand local storms and high winds. I will put it on my house".*

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