Technical data sheet

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Wind loads and metal ceilings

Information for building designers, installers and system manufacturers

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1. General information on wind loads with suspended ceilings

Wind loads are suction and pressure forces that have an affect on suspended ceilings. Suspended ceiling membranes as well as the substructure must be designed in respect of the subjected wind loads to guarantee durability, loading capacity and fitness for purpose.

Wind loads can occur both externally and internally in a building.

Wind loads in **external areas** can vary greatly, depending on the wind zone, geographical location, building type, height of building, floor height, and position of the external ceiling in relation to the building.

When planning and specifying suspended ceilings, definite requirements in the form of load assumptions are often missing for the suspended ceiling to be installed. In practice, we often only find general requirements such as “storm-proof” or “wind-proof” suspended ceilings. In addition wind speeds and height of the suspended ceiling above the ground may be stated. These requirements alone are no reliable basis for planning and design.

Wind loads **internally in buildings** are subject to the same influences when large open windows or doors that can be open in all weather conditions are present in buildings.

The following statements regarding technical regulations should provide those involved in construction with a practical approach to the planning and design of wind loaded suspended ceilings.

2. Technical regulations for wind loads

2.1 EN 1991 – 1 - 4 April 2005

This standard is the European basis for the structural design and the calculation of impacts on the supporting structure. Part 1-4 deals with the impact of wind loads on supporting structures.

2.2 National standards

In addition to EN 1991, national standards and national specific building regulations are also used for regulation.

In Germany this is DIN 1055 – March 2005, which is discussed in section 4 regarding the impacts of wind loads on supporting structures and in section 7 regarding the impacts of temperature.

The elementary parts of DIN 1055 correspond with the European standard EN 1991-1-4.

However, national standards (e.g. NEN 6702 in the Netherlands) should be regarded with precedence. As a rule, they contain wind zone maps.

2.3 DIN 1055-4

DIN 1055, part 4 contains the determination of subjected loads and guidelines for the calculation procedure of the relevant safety inclusions of the determined loads for Germany.

2.4 EN 13964 – 2004 + A1:2006 (D)

This standard only regulates requirements and test methods for suspended ceilings for use internally. The CE mark applies only to ceilings used internally.

EN 13964 regulates the general technical principles for suspended ceilings without providing specific, comprehensive regulations for external ceilings.

Paragraph 4.3.5 of EN stipulates that possible wind loads in internal areas should be taken into account according to the regulations of EN 1991-1-4.

Where appropriate, special tests should be carried out for wind loads in internal areas (see EN 13964 paragraph 5.3.3 functional test in conjunction with annex G).

For suspended ceilings that are not covered by EN 13964, appropriate regulations for the inclusion of wind loads are required. DIN 18168, part 1, April 2007 and draft DIN 18168, 2.2 (for plasterboard ceilings) do not contain clarification regarding the wind load requirements.

3. Wind load on metal ceilings in external areas

3.1 Basis of calculation

The calculation basis for metal ceilings used externally is EN 1991 – 1 to 4 – April 2005, for Germany DIN 1055 – 4:2005 or another national regulation.

3.2 Expected loads

According to the above standards, all external ceilings with expected wind loads (pressure/suction loads) are to be individually specified by the building designer for every building or every ceiling area and position on the building. The calculation is based on wind zone maps, wind speed, height above ground, gust accumulation pressure and turbulence.

The load determining factors are periodically adapted to reflect changes in the safety calculation due to climatic change.

When calculating the applied loads, the current, valid version is to be used.

The applied loads are to be specified by the building designer in consideration with the current standards.

3.3 Design of the system components

In order to control the loads caused by wind loads from a safety point of view, all construction components (ceiling membrane, substructure) should be calculated according to the expected pressure/suction loads on the suspended ceiling.

The calculation is made according to approved, structural methods.

To be calculated for the given loads are:

1. the ceiling membrane and ceiling components

2. substructure profiles and hangers as well as the installed centre-to-centre distances of the profiles and hangers

3. the calculation of the hangers for the estimated load depending on the suspension height

Structural verification of point 1-3 has to be done in writing and on the basis of EN 1991-1-4 or national standards (e.g. in Germany according to DIN 1055). When tests are included in the verification, they should be traceably documented. The structural verification must in principle be verifiable.

3.4 Interaction of involved parties

3.4.1 As a rule, the building designer has all the necessary knowledge of the individual building. The expected loads are to be specified by him for every ceiling area and position.

3.4.2 As a rule, the system manufacturer has all the parameters of his system that must be entered in a calculation for a given load. Normally, he has no local knowledge.

The calculation of the ceiling system for the required loads can be carried out by the system manufacturer providing all of the stated expected loads in point 3.2 have been provided.

3.4.3 The installer and/or contractor usually have neither local knowledge nor details about the respective ceiling systems. It is their responsibility to demand the load assumption from the building designer. The calculation of the ceiling system can be done by the system manufacturer or alternatively calculated by the installer taking into account the relevant data from the system manufacturer.

The system manufacturer and the installer are not responsible for the load determination.

4. Additional requirements for wind loads in external areas

4.1 Type of ceiling membrane and substructure

Ceiling membranes with different characteristics can be used, e.g. closed / open, perforated ceiling membranes with corresponding joint patterns (closed or open joints), and expanded metal with different mesh forms and mesh sizes as well as different metal grids.
Substructures and ceiling membranes should be compatible.

Depending on the assumed wind loads, in the case of additional loads, dimensions, structural dimensioning and quality of the substructure and the ceiling membrane, e.g. fixtures (luminaires) should always be agreed by the installer with the system manufacturer in individual cases.

4.2 Hangers

Hangers such as threaded rod and Nonius hangers must be reinforced, if necessary, with additional measures depending on pressure and suction loads as well as suspension height (buckling).

4.3 Load transfer to surrounding components

Depending on the design of the ceiling construction, vertical and/or horizontal loads can occur on the surrounding building components such as facades or bulkheads. If no or only limited loads may be transferred to surrounding components, this should be stated in the specification by the building designer.

4.4 Plugs and screws

The building regulation approvals of the plug manufacturer for “external areas“ are to be considered together with the load data during the installation. Other fixings, such as screws, must meet the above requirements.

4.5 Physical construction requirements

Requirements such as adequate ventilation in the ceiling void to prevent condensation (building damage/corrosion) or the provision of adequately sized thermal insulation to prevent cold bridges are important parameters that are to be incorporated by the building designer.

In the case of metal ceilings, thermal expansion due to temperature fluctuations should be considered during the design phase. In Germany this is based on DIN 1055, part 7, which considers an external temperature from -24° Celsius to a maximum +35° Celsius.

4.6 Corrosion protection

Suitable corrosion protection systems must be used for the entire system, including its connections.
The type and level of the corrosion protection is to be specified by the building designer.

4.7 Safety

The manufacturer’s guidelines on inspection and maintenance should already be taken into account during the planning and

design stage of ceilings for external use.

4.8 Installation

The installer / contractor must fulfil all the specifications of the building designer and the system manufacturer.
The system manufacturer has to prove the suitability of the ceiling system to the requirements, including installation guidelines.

It should be noted that only components approved by the manufacturer may be used. If the installer uses other components that are not specified by the system manufacturer, then he alone has the responsibility to attest the conformity of the changed system.

5. Wind loads on metal ceilings inside buildings

5.1 EN 13964

Suspended ceilings are principally regulated in EN 13964:2004 + A1:2006 (D).
In point 4.3.5 wind load resistance, no specific loads are given.

As a rule, metal ceilings can be used against vertical wind forces from 20 – 60 N/m² due to their construction, without any additional measures.

5.2 Calculation of wind loads in internal areas

For the calculation of wind loads in internal areas, the principles as already described in point 3 of this data sheet apply.

However, in accordance with EN 13964 5.3.3, in case of wind loads, it is always necessary to carry out a functional test on hangers according to annex G.

6. Summary

Wind loads must be bindingly identified and provided for every loaded area. This task is the responsibility of the building designer.

The responsibility for the structural design /dimensioning of the suspended ceiling for the loads provided by the building designer lies with the system manufacturer. In individual cases this can be done by the installer/ contractor in cooperation with the system manufacturer.

The following diagram illustrates the allocation of responsibilities for wind loads in case of metal ceilings.

Responsibility of the building designer	Responsibility of the system manufacturer	Responsibility of the installer / contractor
- selection of the metal ceiling system - detailed identification of the expected pressure/suction loads - requirements for corrosion protection	- structural design of all system components to the load requirements of the building designer - verification and installation guidelines for the design, especially construction and hanger centres for the load requirements	- installation of the manufacturers system components according to the installation guidelines - declaration of conformity and structural verification in cooperation with the system manufacturer