Scuola universitaria professionale della Svizzera italiana
Dipartimento ambiente costruzioni e design
Istituto sostenibilità applicata all'ambiente costruito

SUPSI

New test procedures for PV modules

Mechanical load test for PV modules on structures

35 mm hail testing

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STS 531

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PV modules systems

Different installation type:

Roof systems

Flat roof systems

Free field systems

Building integrated systems

Different module construction: glass / glass - laminates – framed glass - flexible - ….

Different fixing systems module -structure: fixing with clamps – screwing on frame – gluing

For one PV module we can have great number of combination to test/validate in different PV systems

Mounting system (material) and installation (labor) becomes a increasing part of the cost of the PV systems since the modules price decrease, in particularly for unframed modules and for BiPV

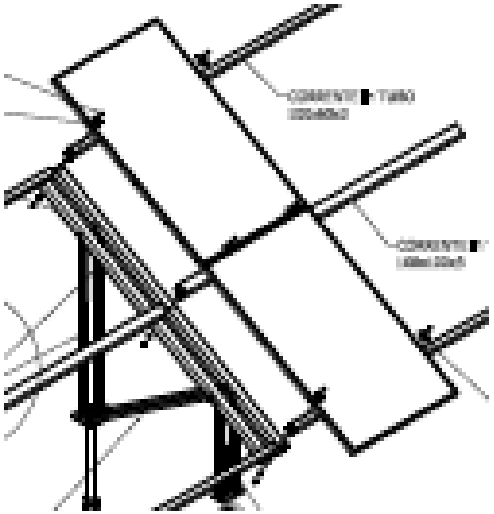
To reduce investment cost installers want to use less clamps – smaller bar – less screws – cheaper materials etc. **but they have to validated the solutions !**

Requirements for PV module mounting systems

A mounting system is composed mainly of three component:

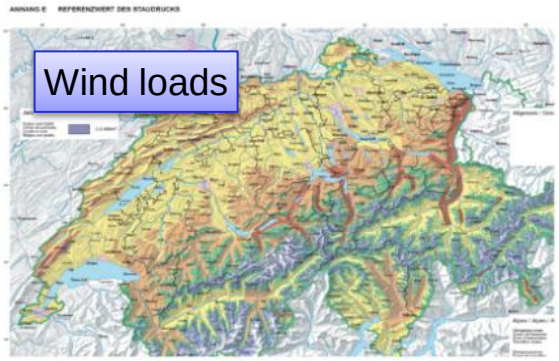
1. Mounting structure: bars …
2. Clamps – screws etc. for fixing
3. PV Module

Requirements:
Full fill the requested standards for modules – construction - safety



Other requirements:

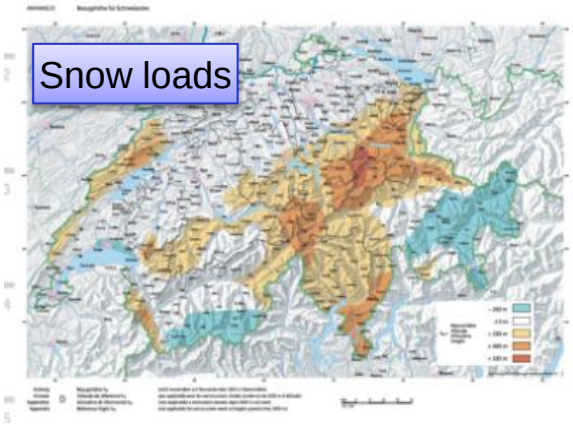
- Easy mounting
- Fast mounting
- Cheap material
- Corrosion resistance
- Easy maintenance
- Easy replacement of modules



Mounting system has to withstand the local wind and snow loads

Wind and snow loads are determined by Euro Code (in Europe):

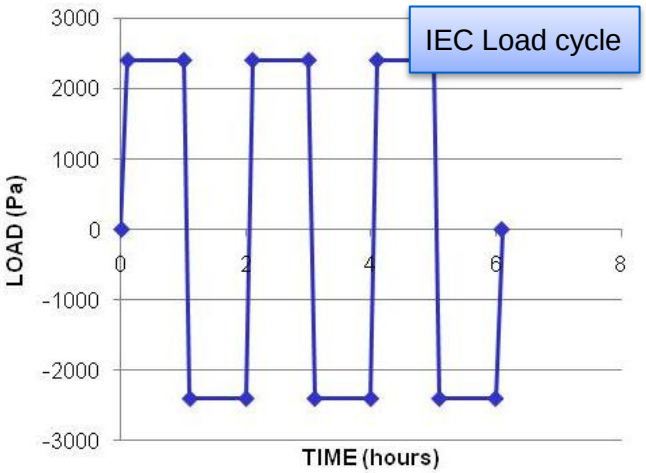
- Countries are divided in Zone 1-2-3-4
- Load calculated depending on installation condition (roof – free standing - …)
- Location (altitude for snow)



Standard IEC 61215 / 61646 mechanical load testing

Scope of the test:

To determine the ability of the module to withstand static snow and wind loads



Test procedure:

1. Fixing of the module with the **worst case** indicated by the manufacturer

2. Test with 3 cycles of:

- 1 hour 2400 pa in pressure
- 1 hour 2400 pa in traction

If requested for high snow loads 5400 pa in the last pressure cycle

3. Continuity detection of the PV module during the hole test

Final requirements:

For all IEC:

- No continuity interruption
- Visual inspection passed
- Insulation (> 40 Mohm*m^2)

For IEC 61215: $\Delta P_{max} < 5\ \%$

The mechanical load tester at our test centre

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Characteristics:

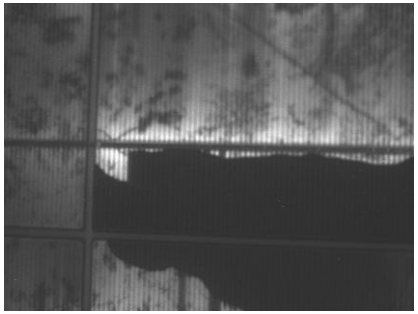
- 20 pneumatic pistons with vacuum cups
- System air pressure 1.5 bar to 6 bars
- Load force on PV module: 500 pa – 9000 pa
- Continuity measurement of the PV module
- Position sensors for vertical displacement of the module
- Test cycle PLC controlled
- Data acquisition with PC (pressure – continuity – displacement)

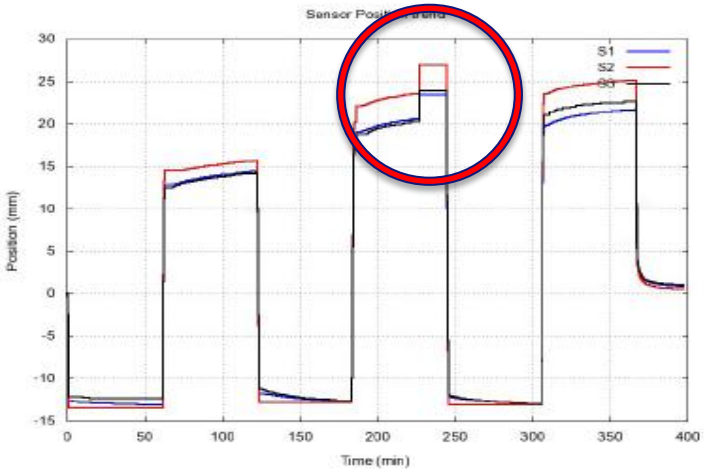
Calibration of the system

Minimum once a year with calibrated pressure gauge (ISO 17025)

New analysis methods:

EL photography before and after testing (since June)





Displacement of PV module on three points

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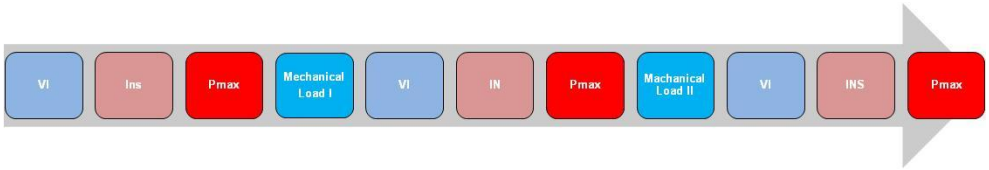
ISAAC test procedure for mounting systems

Scope of the test:

To determine the ability of the **mounting structure and the PV module** to withstand static snow and wind loads

Mounting of the structure and fixing of the module as described in the manufacturer description or in accordance with the installation



Different load cycles:

- IEC load cycle
- Incremental load force (traction or pressure)
- Incremental with back to zero

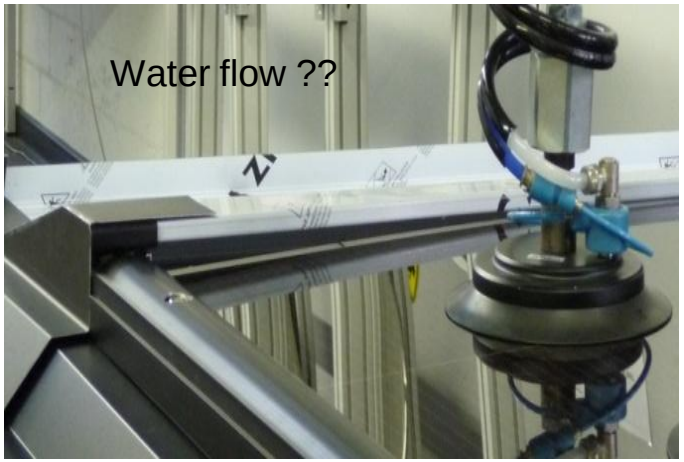
Final requirements:

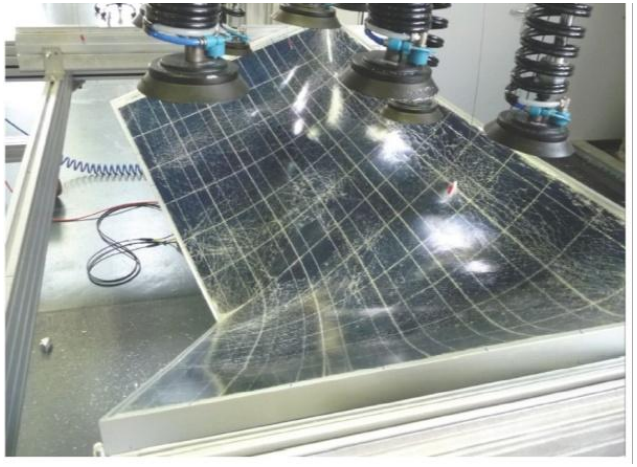
For all modules:

- No continuity interruption
- Visual inspection
- Insulation
- No permanent deformation of structure screws - fixings

For c-Si: $\Delta P_{max} < 5\ \%$

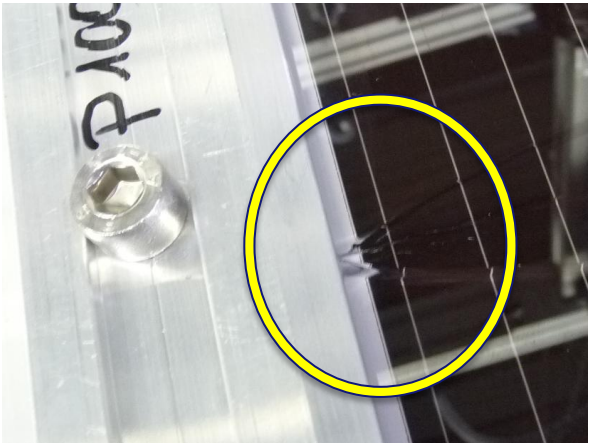
See problems with structure





No standard fixing points but at the extreme points:

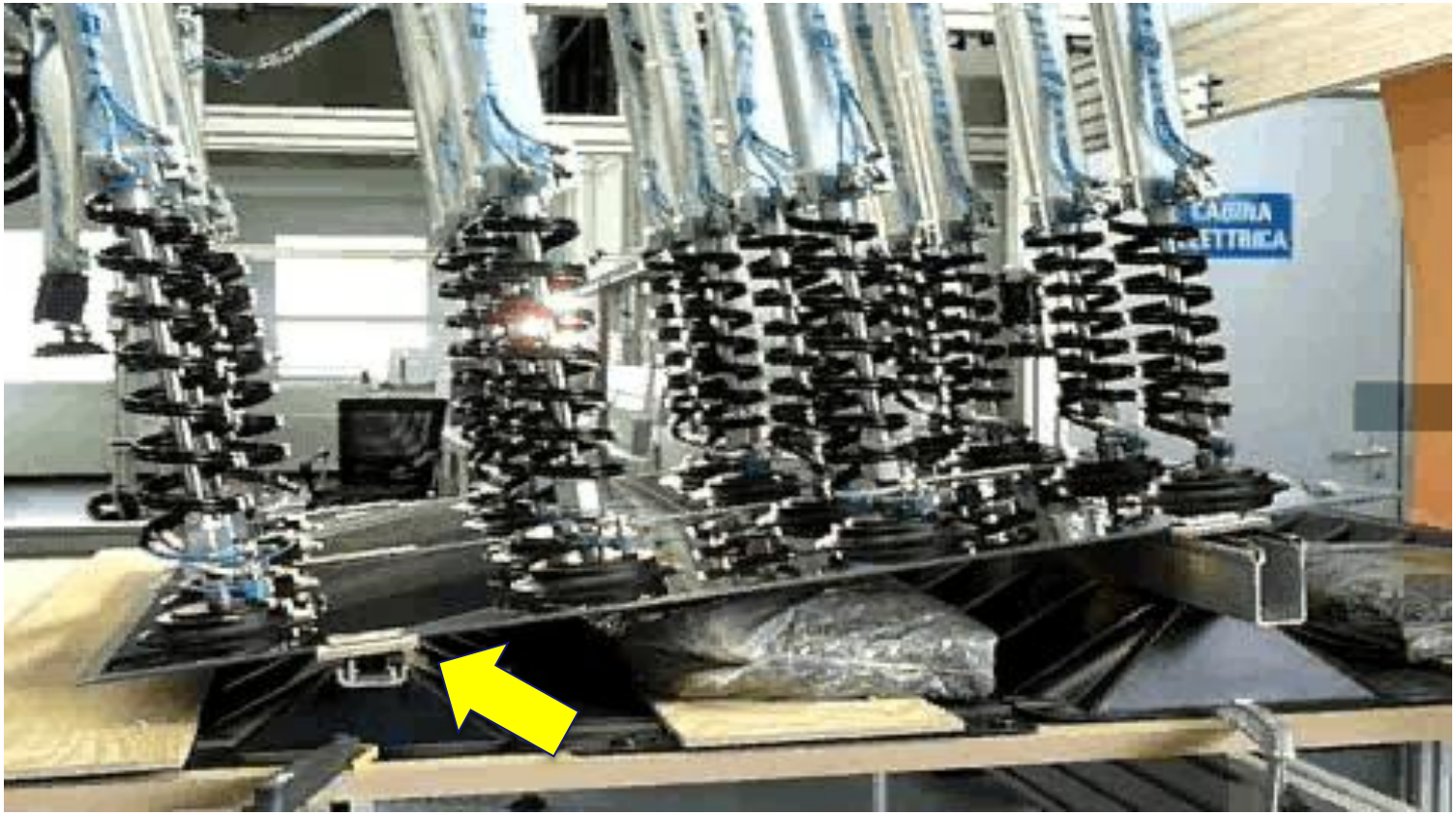
Module tested at 5400 pa from manufacturer is not able to withstand in this conditions



Cracks starting from edge of clamps

Cheap solutions

Test executed at the Test Centre

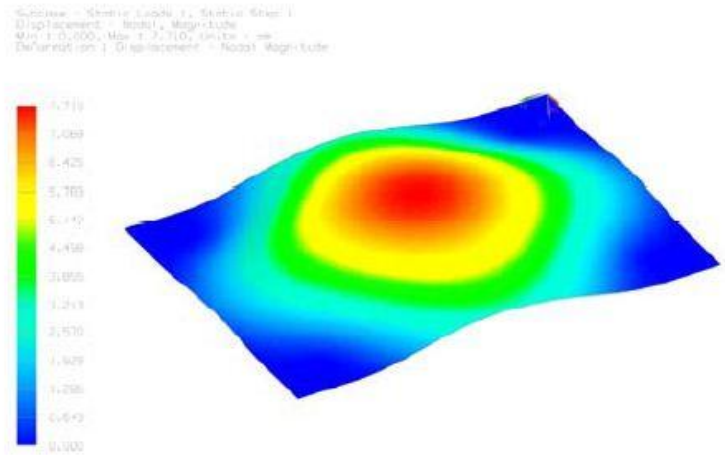


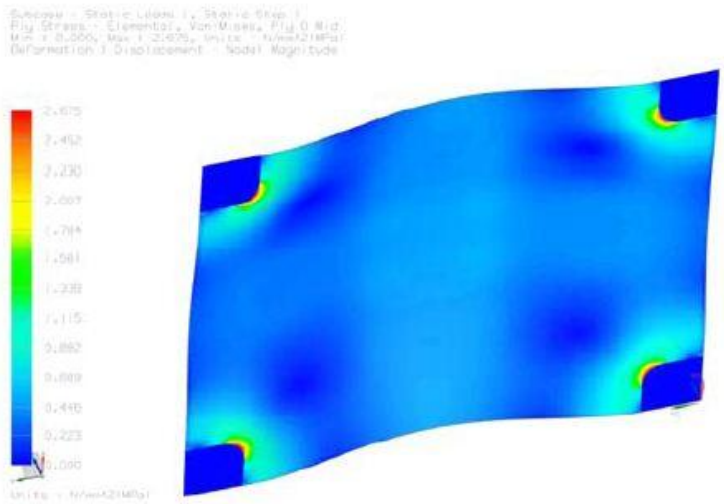
Flat roof system for glass – glass modules with fast clamping system

Test in traction revealed problems with the external clamp design (asymmetric force) – limit 1000 pa

After testing the design was changed and then the test passed successfully with 2400 pa

Simulation with FEM





1° modeling:

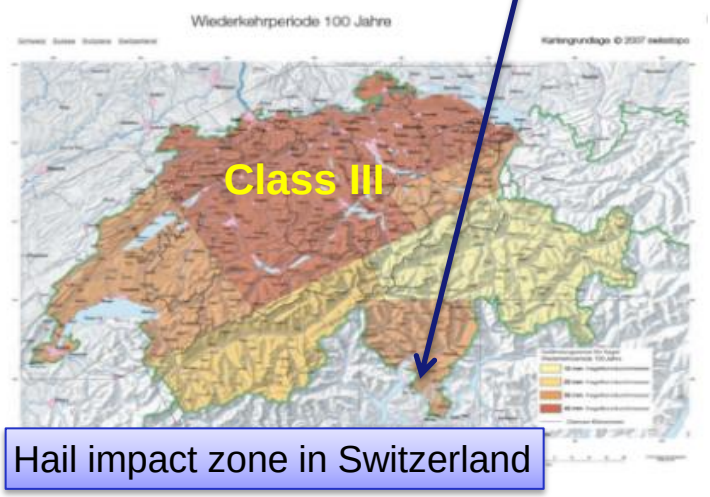
- Module: glass/glass
- Clamping: 4 clamps
- Structure: rigid bars

Scope:

Easy and cheap prediction of the behavior in case of change of clamp number – fixing point or load

Hail testing with 35 mm diameter

Exceptional hail storm near Lugano in 2005



Hail impact zone in Switzerland

Standard IEC condition:

Diameter: 25 mm
Mass: 7.5 g
Speed: 23 m/sec

Class III requested in Switzerland from the government insurances

~ IEC 35 mm

Diameter: 35 mm
Mass: 21 g
Speed: 28 m/sec

Influence of ice temperature:

IEC -4°C
CH - 20°C

Difference in impulse transfer due to ice temperature: 20%

Hail impact with 35 mm diameter and speed 40 m/sec

Thin film module superstrate: tempered glass 4 mm
substrate float glass 3.2 mm

Conclusions

A) IEC standards covers only PV module:

No consideration of mounting system (fixing – structure)
No consideration of location and installation type (local loads)
(Only static testing)

B) Increased hail testing if the local standards or the local risk are higher then the IEC standard testing

NEED OF ADDITIONAL TESTING ? !

Who ?
Module manufacturer
PV structure manufacturer
PV system planer / installer

For further information:

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