

PLATFORM MEETING

L'esperienza dei Progetti LIFE per la sostenibilità ambientale
dell'industria Ceramica e dei Laterizi



**Incremento del risparmio energetico per il raffreddamento
degli edifici grazie alla forma delle tegole ottimizzata per una
maggiore ventilazione sottotegola**

**High Energy savings in building cooling by Roof Tiles shape
optimization toward a better above sheathing ventilation**

Mario Cunial– Industrie Cotto Possagno SpA

HEROTILE (LIFE14 CCA/IT/000939)

Sassuolo – 11 aprile 2017



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Project Location

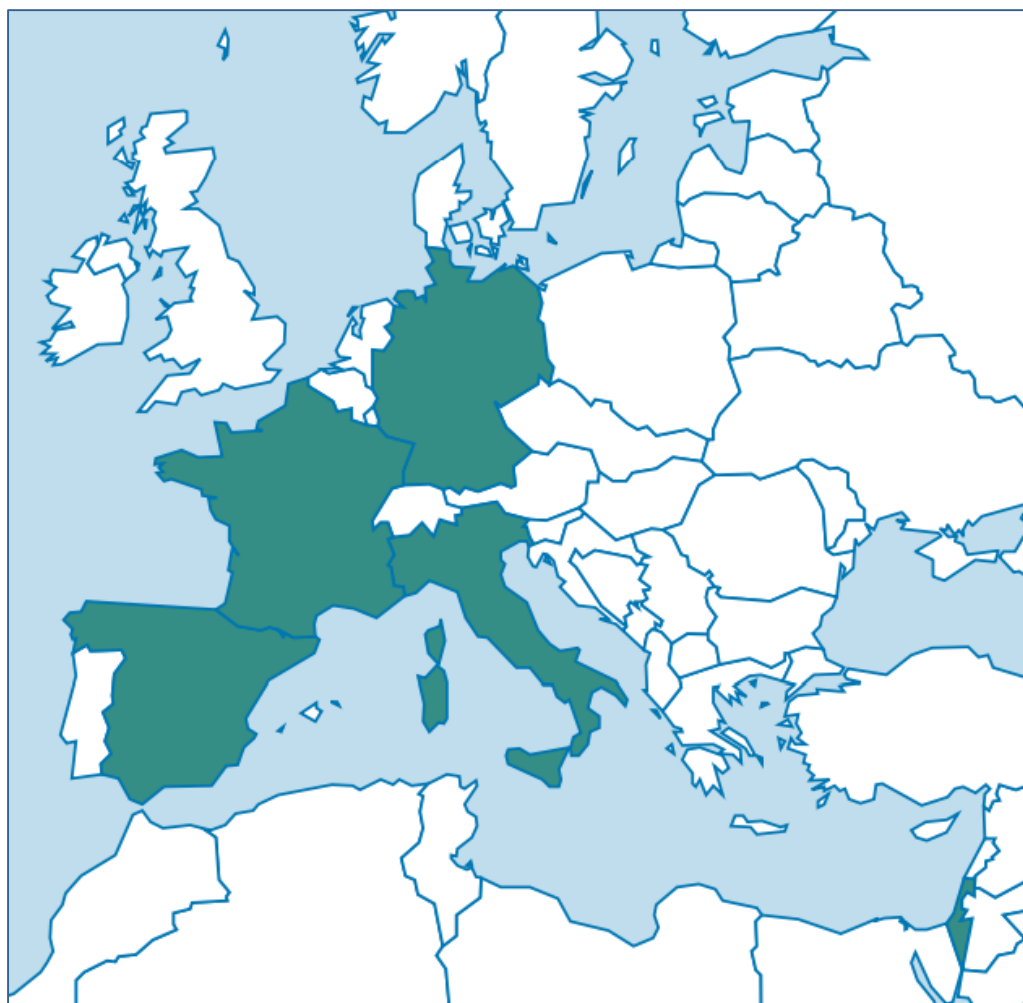
Italy, France, Germany,
Spain and Israel.

Cost of the project

2.515.306,00 €

% EC Co-funding

60%



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CERAMICA E LATERIZI



MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE



TARGETS OF REDUCTION OF THE ENVIRONMENTAL IMPACTS IN THE BUILDINGS OF THE SOUTH OF EUROPE

- 10% Greenhouse gas emissions
- 50% Carbon footprint of building space cooling (in comparison with the standard pitched roof)
- 5% Air pollution
- 5% Electrical power for air conditioning in urban area
- 25% Maximum under-tile air temperature
- 50% Specific cooling power

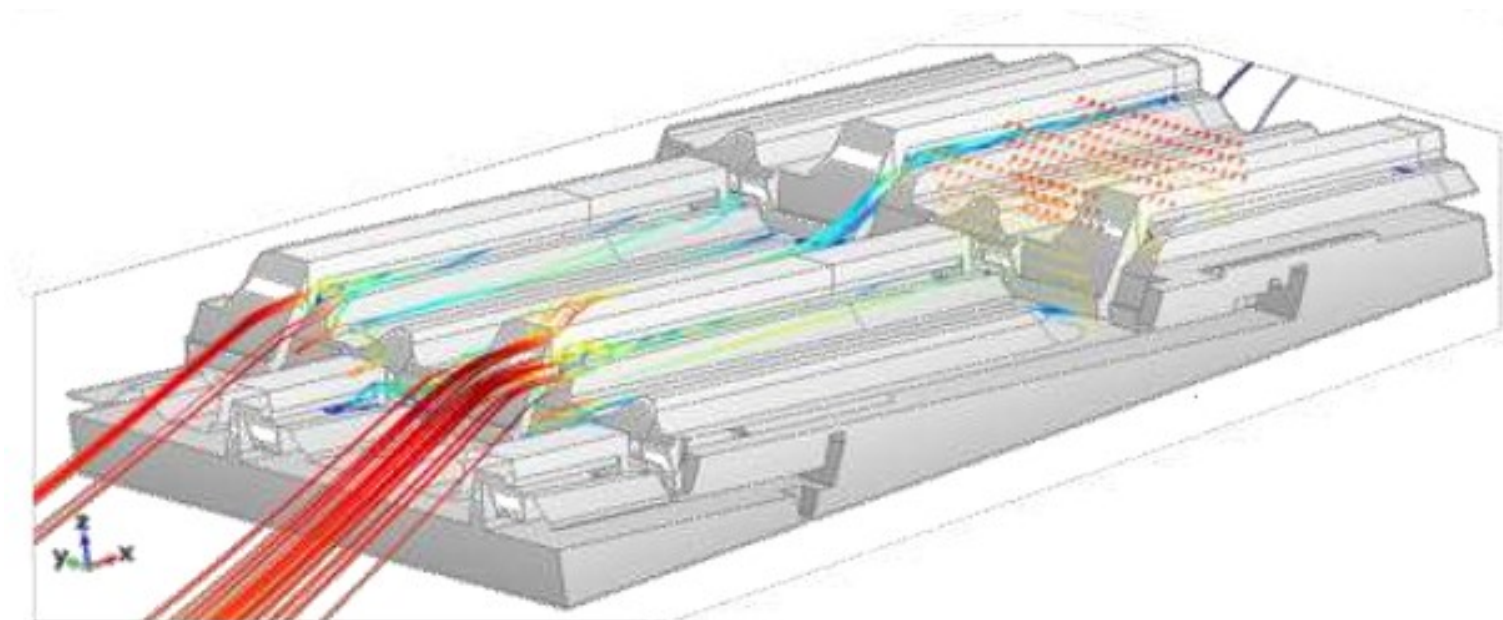
SCENERIES AND IMPLICATIONS

The project is in conformity with the European energetic policies which have the target to reduce the CO2 emissions, as it allows an energetic saving for the air-conditioning, which represents the 40% of the global inquiry of the energy spent by the buildings.

The project proposition acts to check and reduce the requirement of the energy for the cooling, requirement which is not yet regulated by the law in several European countries, the most of whom in the South of the Europe, where the summer power consumption is important and significant.

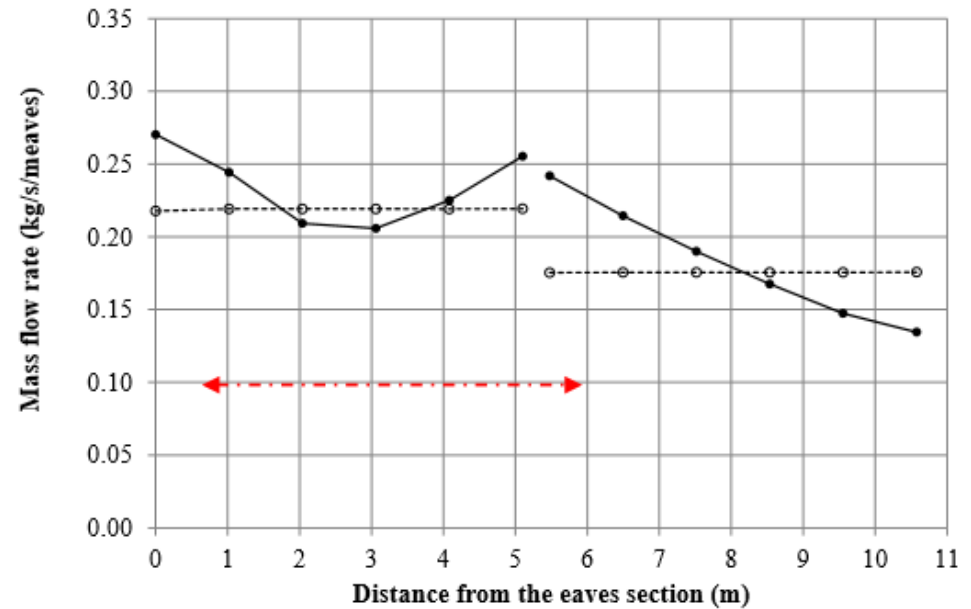
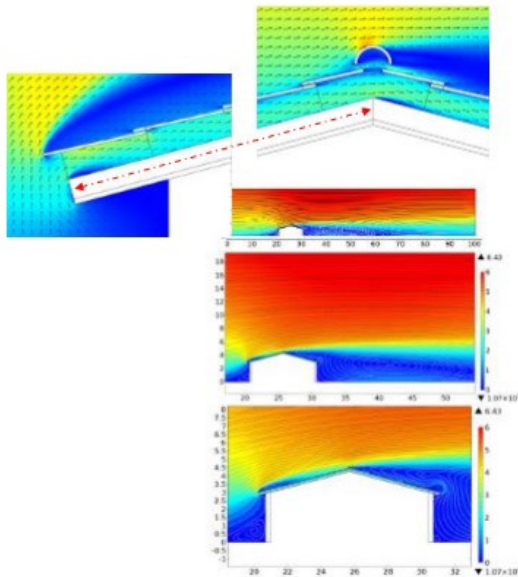
The roof becomes one of the strategical elements to reach the targets of decarbonization 2050 into the buildings. Life HEROTILE will substantially help the buildings sector (renovation and new constructions) to reach the targets of energetic efficiency and of the CO2 emissions lowering, with a durability of the performance practically unlimited and without energetic consumptions and/or maintenances.

CFD analysis



Basis

The CFD model had been implemented to understand how much the roofing tiles could have affected the air permeability.



The results have substantiated the application of such basis on a funding of the UE project, or that part of the project which aims to improve the permeability of the ventilated roof's air in warm and mild climates to increase the insulation of the passive buildings.

ACTIONS:

- 2 pilot plants for the productions of new types of roofing tiles in Italy
- 2 construction tests in real scale, in Italy and in Israel
- 2 demonstrator buildings, in Italy and in Spain
- SENSAPIRO, Software **EN**ergy **SA**ving **P**itched **RO**ofs



ACTION A1



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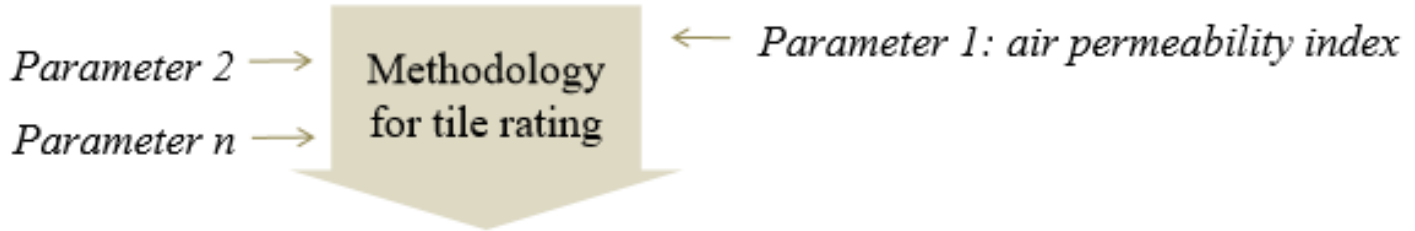
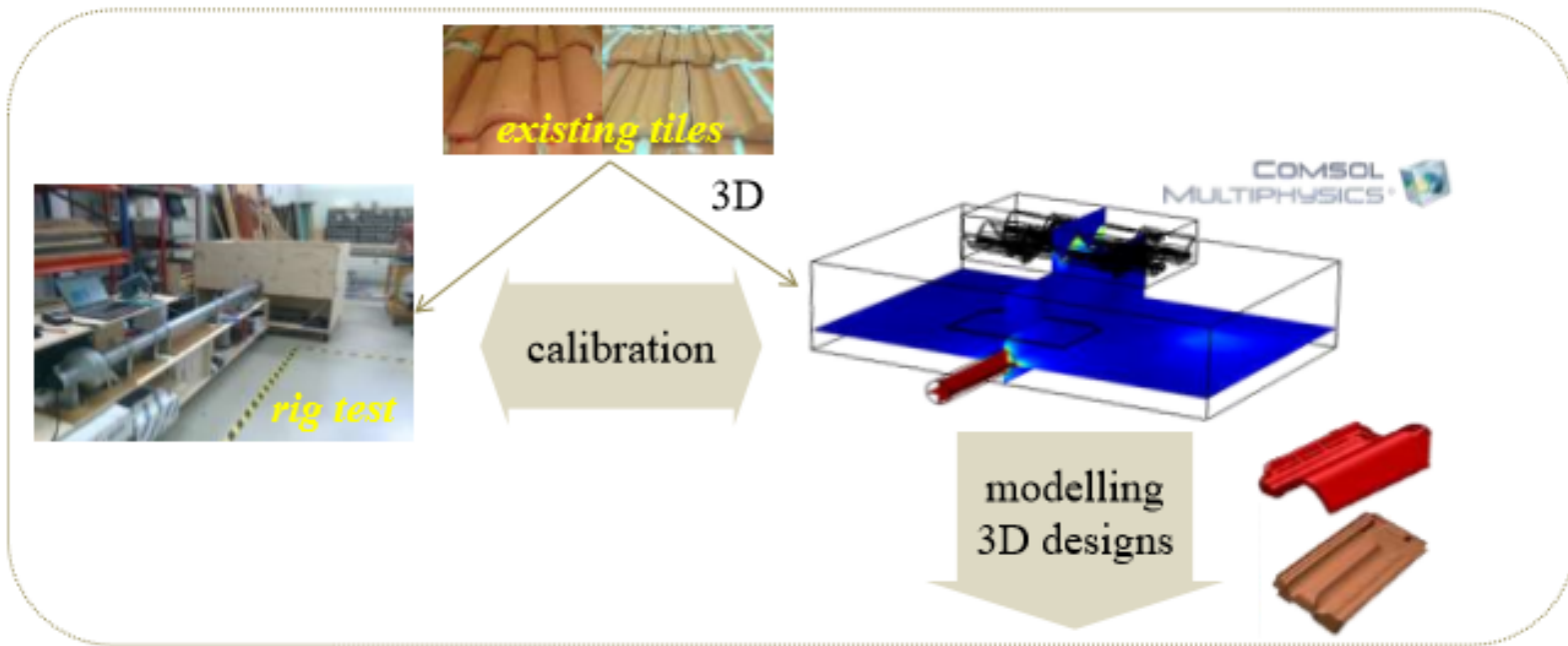
The preparatory action A1 has the target of:

- Create a set of new roofing tiles models (Marseillese and Portuguese);
- Evaluate the results comparing them with the reference roofing tile
- Select an optimal design for the successive phasis

The methodology combines experimental proofs and numerical simulations to evaluate the air permeability of a ventilated sloping tiles roof and to foresee the behaviour of the new models. For this purpose they are utilized:

- An experimental plant for testing the relationship between difference of pressure and volumetric flow of the air on the existing roofing tiles
- A 3D CFD calibrated model to calculate the air flow through the roofing tiles on different conditions.

ACTION A1



Selection of new shapes for 3D printing and testing in wind tunnel

ACTION A1



$$Q = C_d \cdot A \cdot n \sqrt{\frac{2\Delta P}{\rho}}$$

Experimental plant by the Monier Technical Center.

The plant allows to measure the air permeability of a group of tiles.

- Big case to give an uniform pressure and low internal velocities.
- Roofing tiles placed as on a roof with all the couplings sealed, except 4 lateral and head roofing tiles.
- Cooling fan with changing speed to test the effect of the roofing tiles geometry.

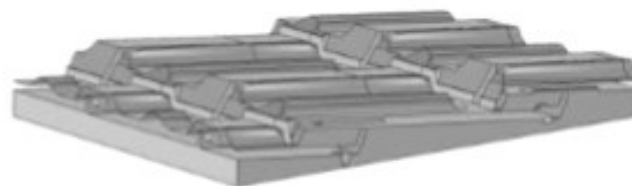
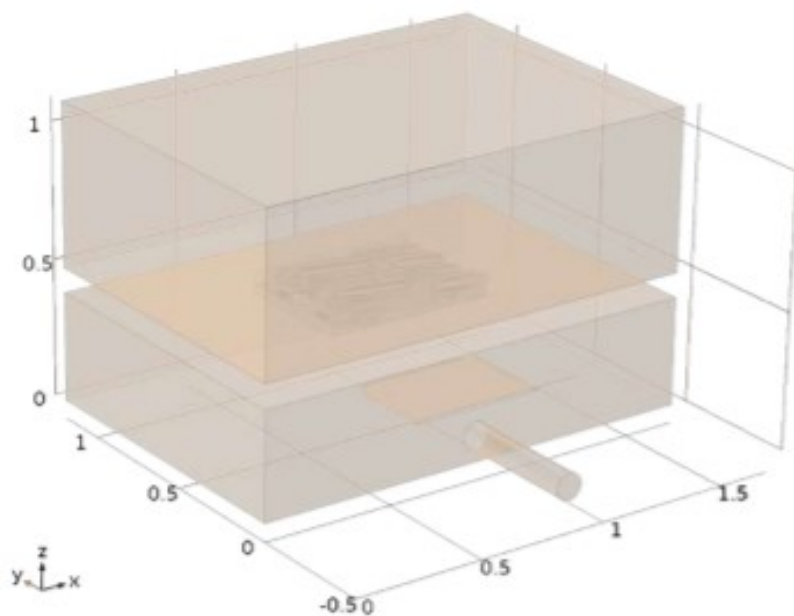


ACTION A1



CFD Approach

3D domain optimized with the borders constituted by equivalent roofing tiles, the box placed above is necessary to set the conditions to the surround.

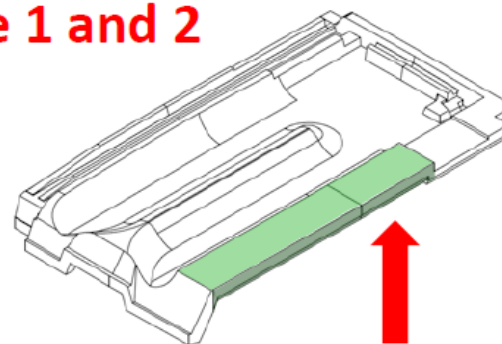
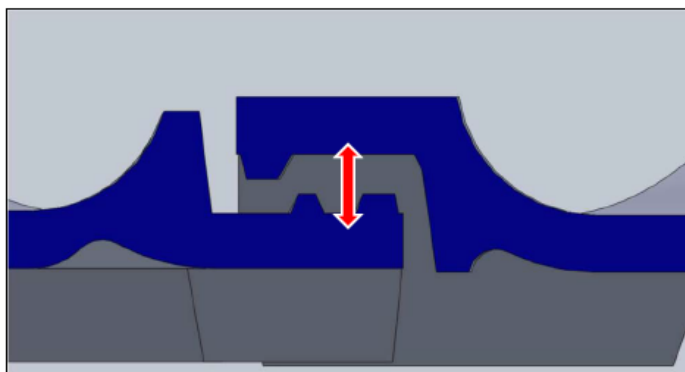


COMSOL Multiphysics V5.2
k-ε RANS-based turbulence model
Boussinesq approximation
steady-state

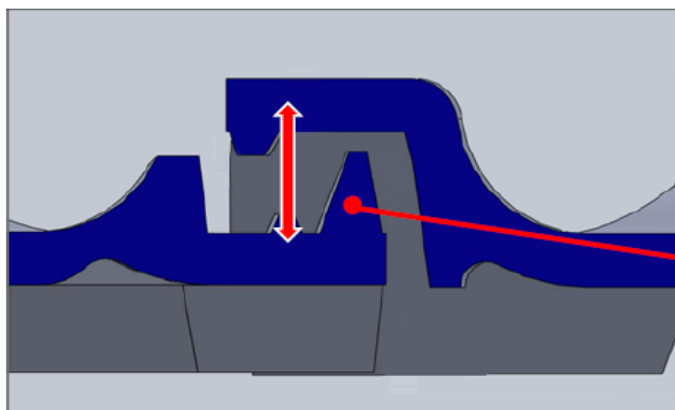
ACTION A1



new tile, marsigliese variation **type 1 and 2**



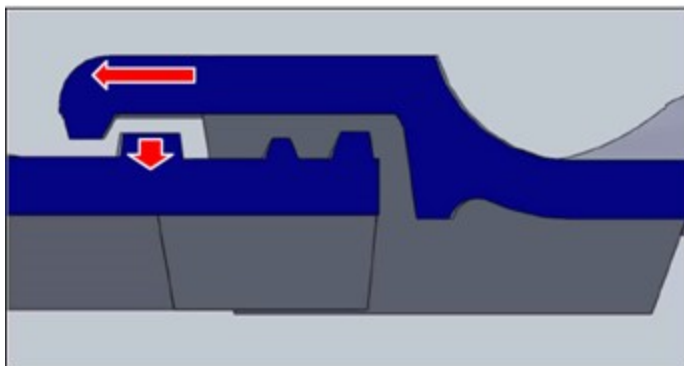
low lifting



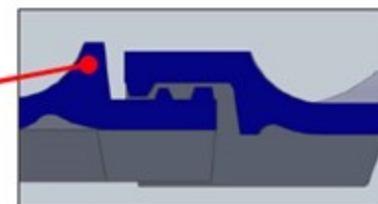
high lifting of the overlapping joint

raise of the internal border

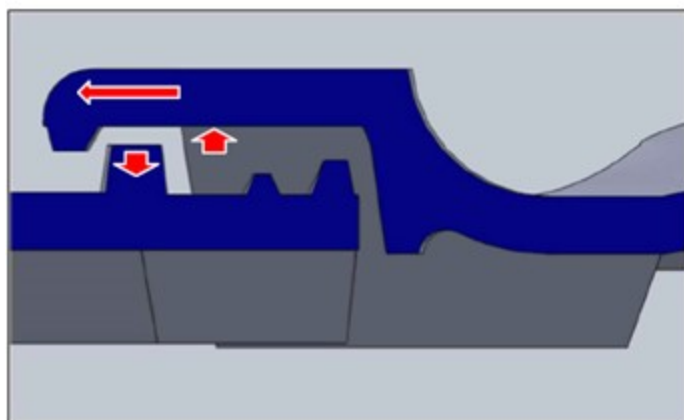
new tile, marsigliese variation **type 3 and 4**



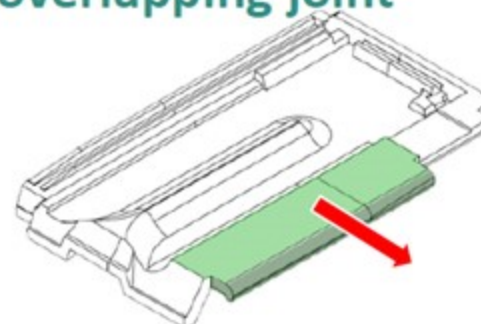
connection
edge
is lowered



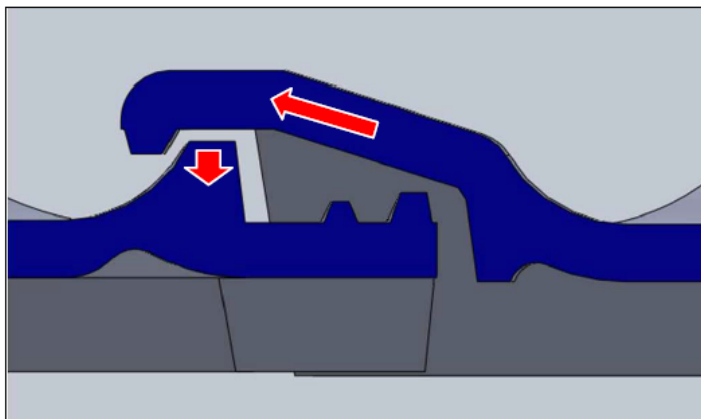
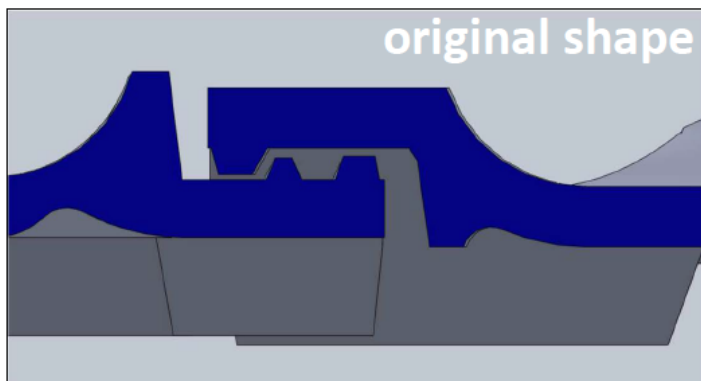
low lifting and shifting



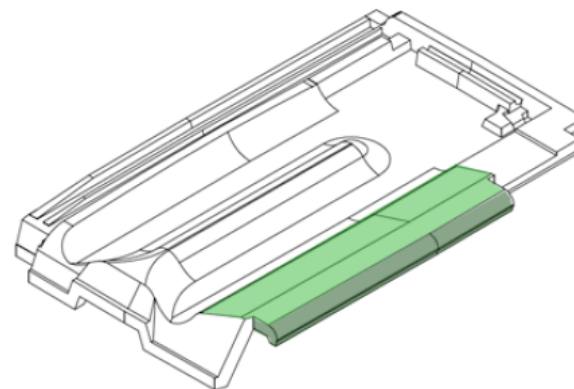
high lifting and shifting
of the overlapping joint



new tile, marsigliese variation **type 5**



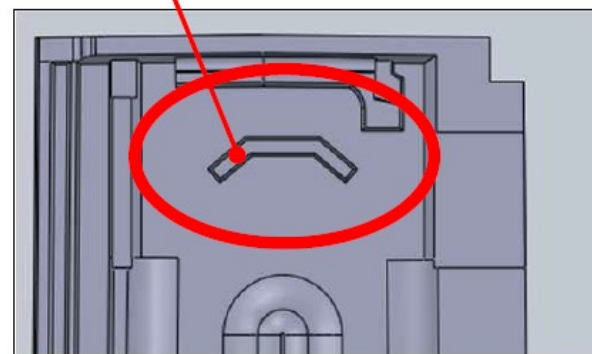
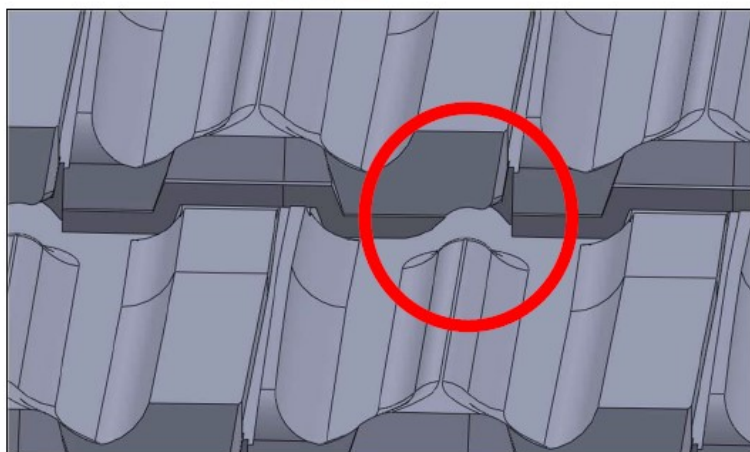
lifting, shifting and tilting
of the overlapping joint



new tile, marsigliese variation **type 6**



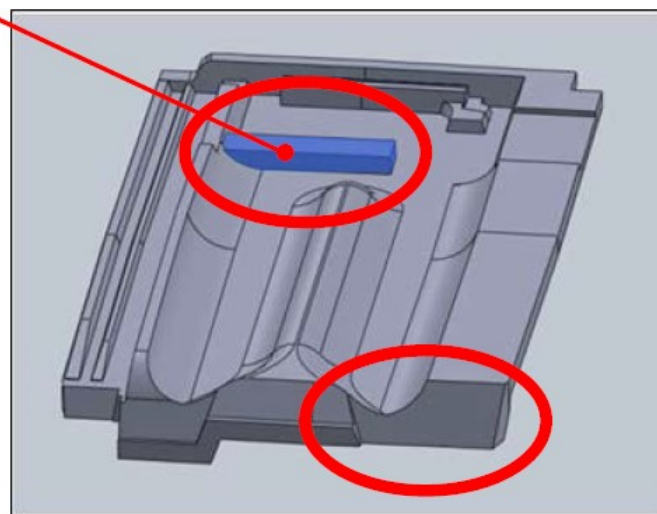
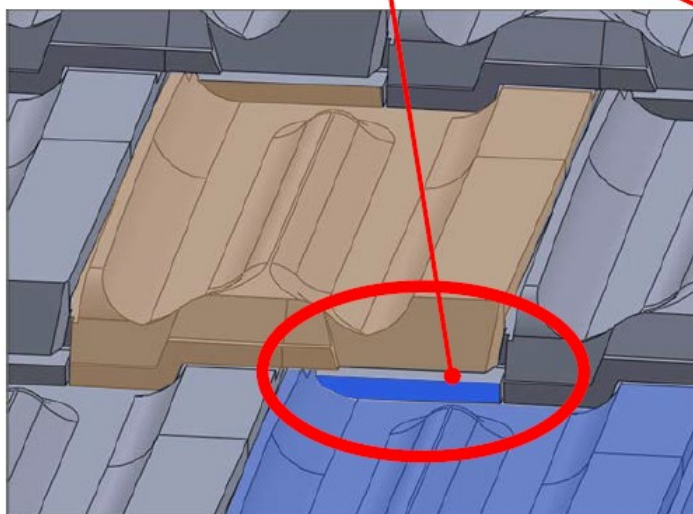
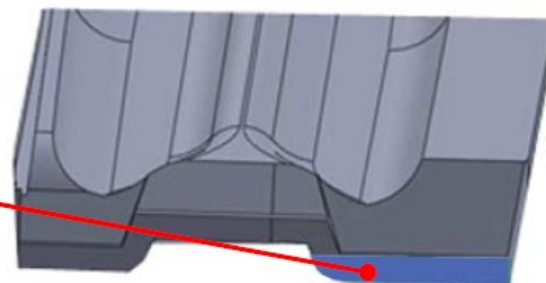
opening an inlet in the corne
on the front and
adding an internal labyrinth



new tile, marsigliese variation **type 7**

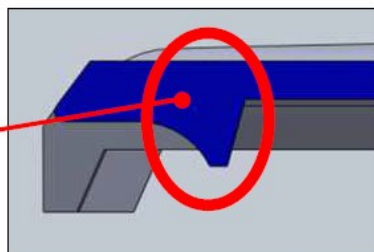
modifying right front

the blue part of the upper tile
is moved on the lower tile
with a smaller thickness
so as to have a open slot

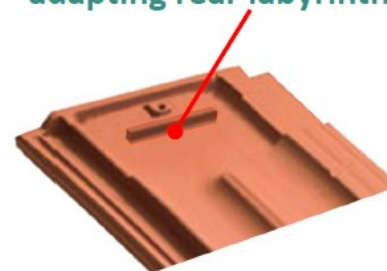


new tile, marsigliese variation **type 8 and 9**

waterproof
adjustment
by lowering
internal flap
(longitudinal section
in the front)



adapting rear labyrinth



opening a **small**

or **large** slot on the front

(*different shape*)



ACTION A1



new tile, marsigliese variation **type 10**

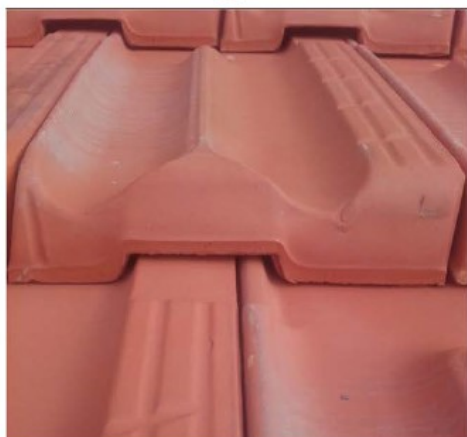


original



new

carving the internal part of the overlapping joint



Description of Tiles

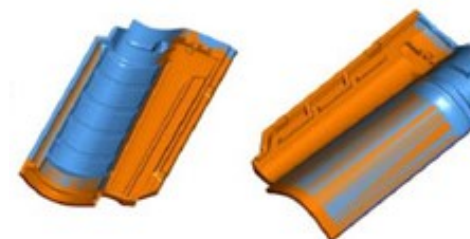
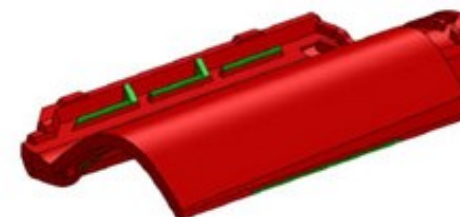


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Three Portuguese tile designs have been considered:

- An existing ICP product «Portoghese Classic» (979)
- A modification of a new tile design (2794) to increase the air flow through the side lock
 - Created by UNIFE, «case 02»
 - Opening in cover lock; raised side lock
- A modification of a new tile design (2794) to increase the air flow through the head lock
 - Created by ICP, based on UNIFE design «case 06»
 - Extended head lock; spoiler in front of nose; opened up area beneath roll



It is a fired clay product
Effects of distortion present in a clay

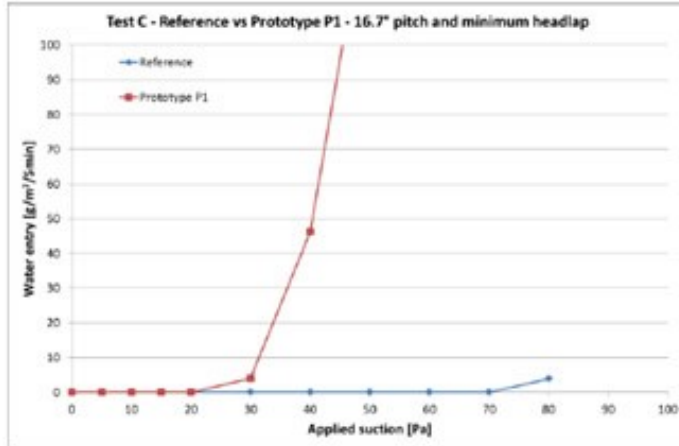
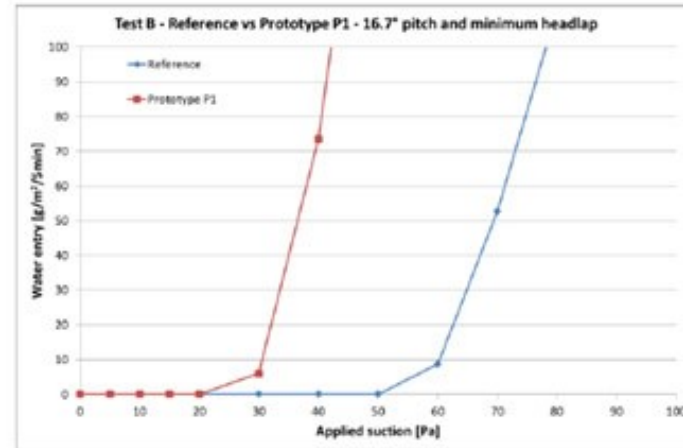
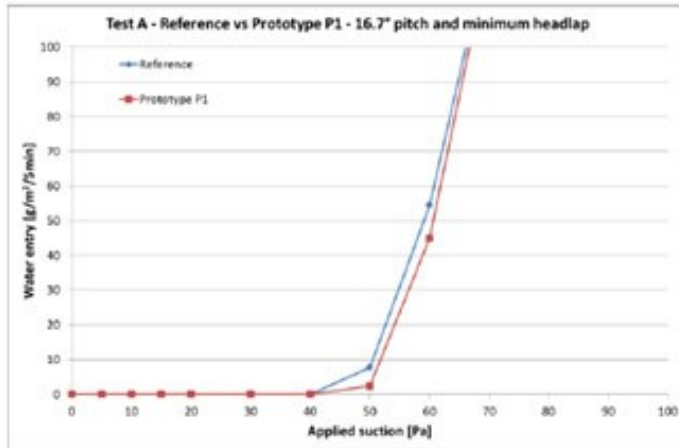
Summary of driving rain wind test method



According to CEN/TR 15601:2012

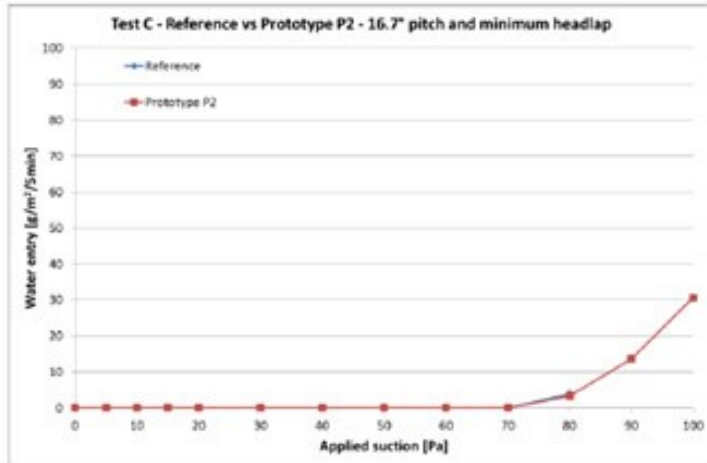
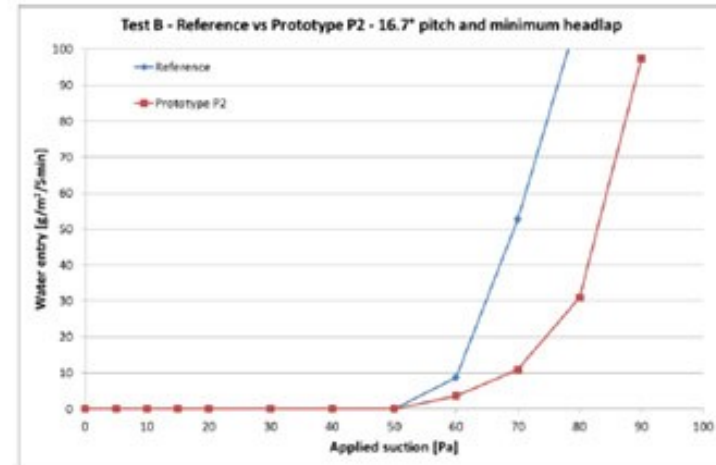
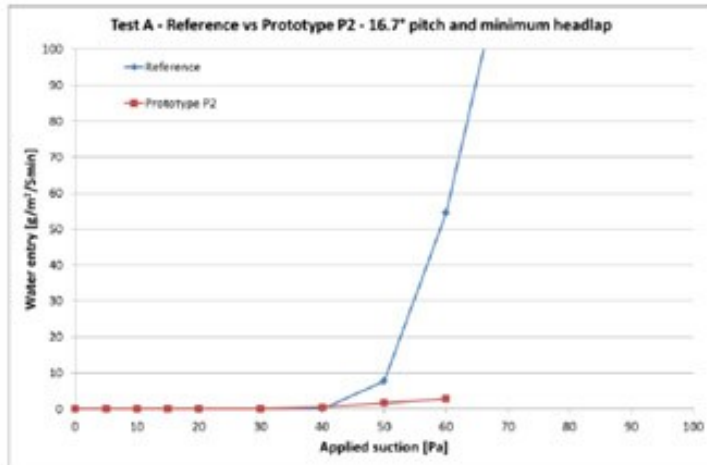
- The roof pitch is fixed to the minimum specified for the tile (16.7°), with the water entry measured as the applied suction is increased incrementally in the following three tests
 - Test A – high rain, low wind
 - Test B – medium rain, medium wind
 - Test C – low rain, high wind
- Test D – deluge rainfall rate, no wind – pitch lowered until the onset of leakage
- All tiles tested at minimum headlap (maximum batten gauge)

Driving rain performance of Prototype P1



Deluge	Roof Pitch [°]
Reference	7.5
Prototype P1	5.0

Driving rain performance of Prototype P1



Deluge	Roof Pitch [°]
Reference	7.5
Prototype P2	5.0

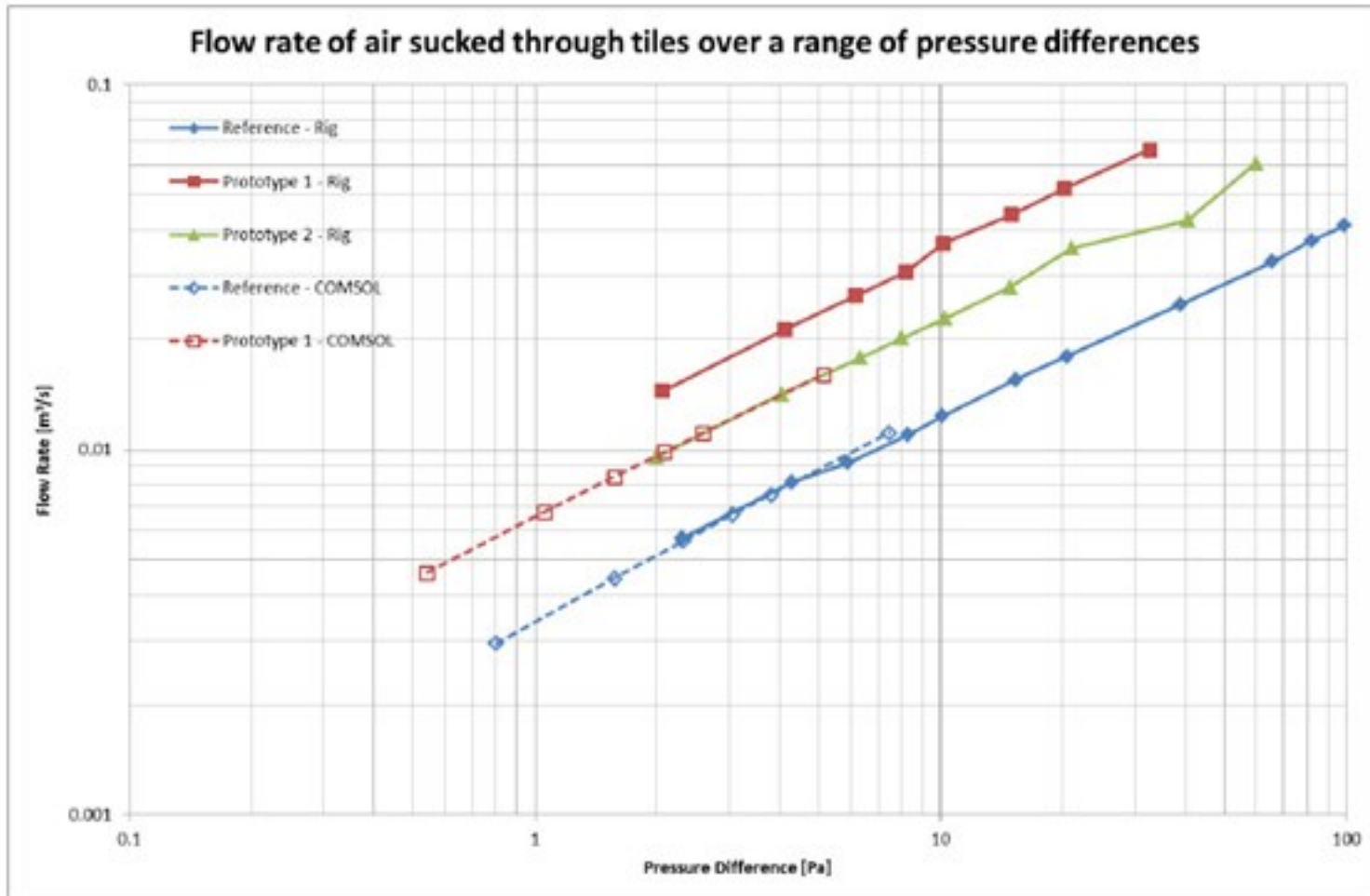
Driving rain wind tunnel performance



Compared to the reference Portuguese tile

- The driving rain performance of the prototype P1 is:
 - Comparable in Test A
 - Lower in Tests B & C
 - Better in Deluge
- The driving rain performance of the prototype P2 is:
 - Comparable in Tests A, B & C
 - Better in Deluge
- N.B. the performance of a modified production clay tile may be different to these gypsum prototypes because:
 - the inherent distortion in a fired product may increase the gaps between laid tiles and, therefore, the amount of water than could get through
 - the prototypes are wet size and the 5-10% reduction in size of a fired product will reduce the lock area and, therefore, the locks may not be able to hold as much water

Air permeability of Prototypes P1 & P2 (suction only)



Air permeability (air sucked through tiles)



The air permeability of the reference Portuguese tile equivalent to 7.0 cm²/tile

- Prototype P1 is significantly more air permeable than the reference tile
 - Equivalent to 18.3 cm²/tile, ~160% improvement in air flow
 - The COMSOL simulation underpredicts the improvement
- Prototype P2 is more air permeable than the reference tile
 - Equivalent to 12.8 cm²/tile, ~80% improvement in air flow
 - No COMSOL simulation is available for this modification by ICP
- N.B. the performance of a modified production clay tile may be different to these gypsum prototypes because:
 - the inherent distortion in a fired product may increase the gaps between laid tiles and, therefore, the air permeability
 - the prototypes are wet size and the 5-10% reduction in size of a fired product may reduce the gap sizes and, therefore, the flow rate

ACTION A1



ACTION A1



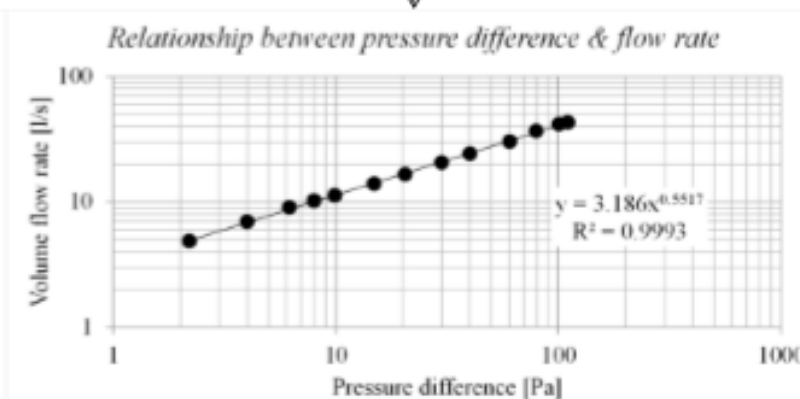
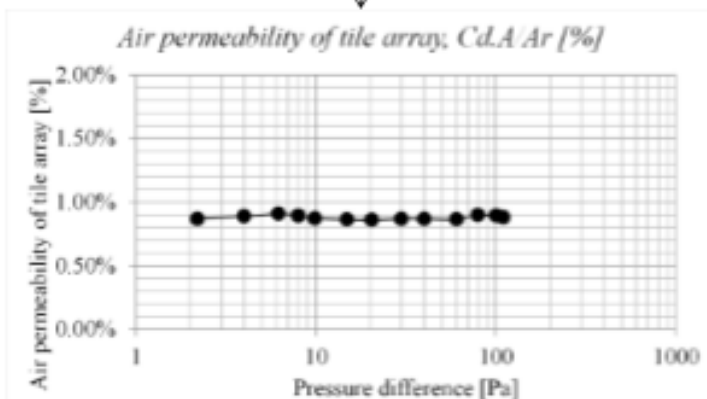
ACTION A1



Aerodynamic area

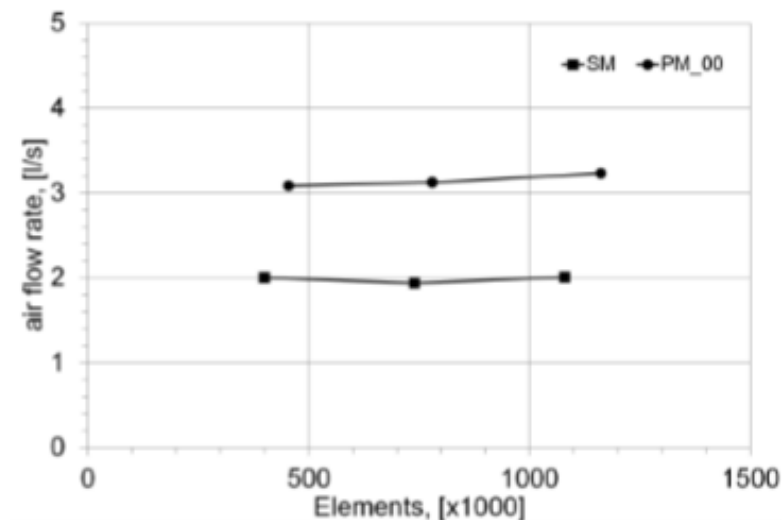
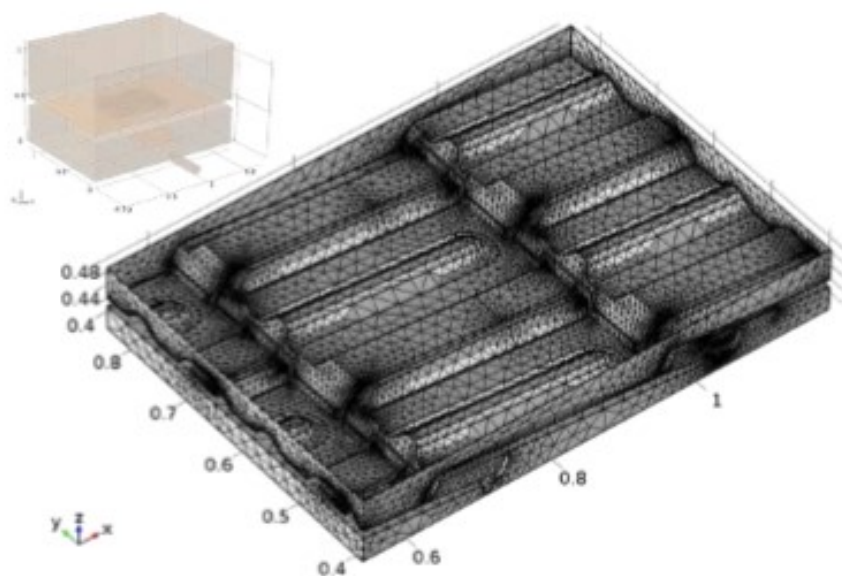
Parameter	Blowing				Sucking			
	Max	Mid	Mid	Min	Max	Mid	Mid	N
"Shunt"	Max	Mid	Mid	Min	Max	Mid	Mid	N
"Headlap"	Mid	Max	Mid	Mid	Mid	Max	Mid	N
Aerodynamic area ($C_d \cdot A$), [mm ²]	2870	2610	2390	2000	3010	2720	2490	21
Flow regime radix (n), [-]	0.546	0.541	0.552	0.550	0.548	0.547	0.556	0.555
Specific aerodynamic area, [cm ² /tile]	7.17	6.51	5.98	5.00	7.53	6.80	6.22	5.41

Batten guage 33.60 cm
 Cover width 20.25 cm
 N No. of headlaps & sidelocks 4
 Effective rig area, Ar 0.27216 M²
 Cd.A 0.002391 M²
 n 0.552
 Cd.A / Ar 5.976 cm²/tile



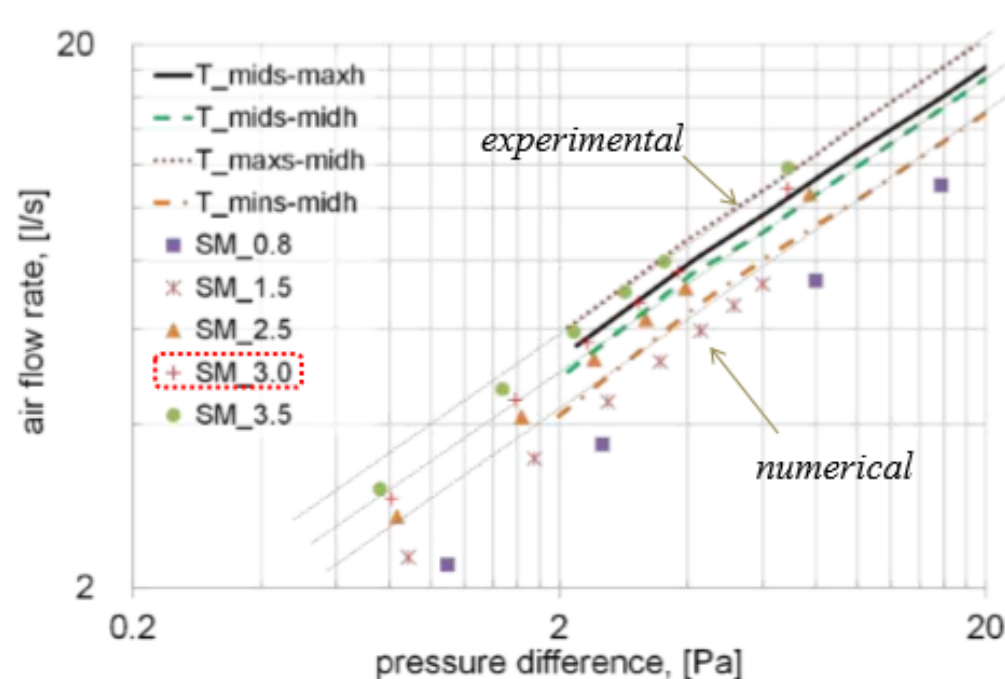
Mesch Dependence

The attention has been reserved to maximize the air permeability details of the roofing tiles, then an analysis of the results has been done.



CFD Calibration

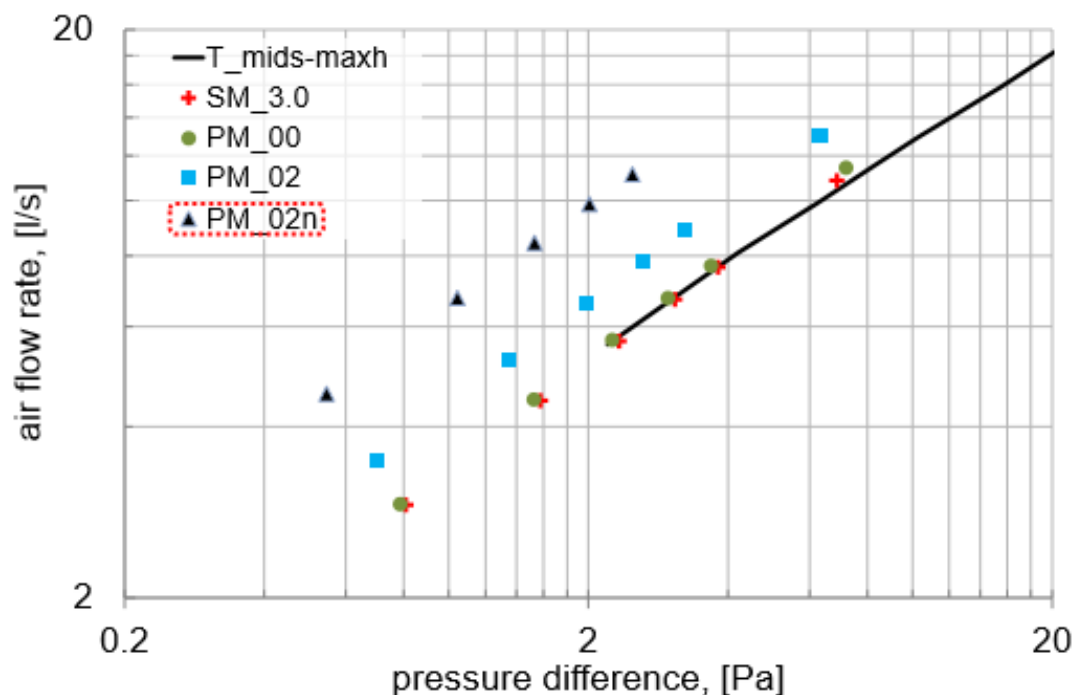
The calibration has been carried out to get the same relationship between the pressure difference and the air flow measured in the experiments.



ACTION A1



The existing rooing tiles have then be substituted with the new models to evaluate their performances.

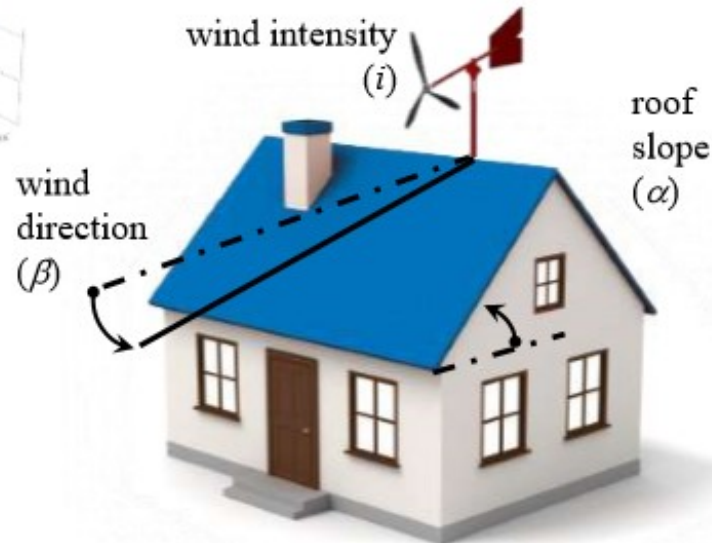
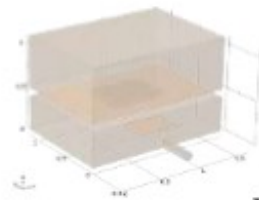


ACTION A1

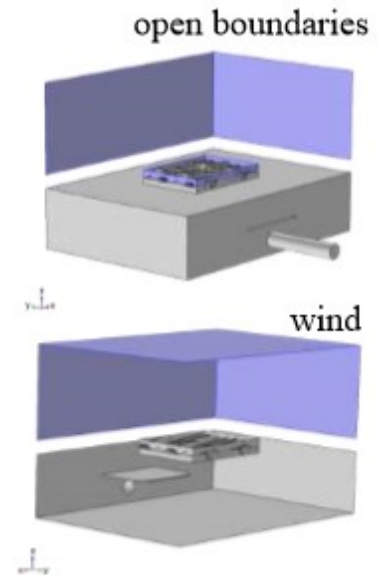


Analysis of the permeability to the air
A parametric analysis has been carried out taking into account of:

- 4 wind intensity: 0,5-1,0-2,0-5,0 m/s;
- 6 incidence angles of the wind: 0-15-30-45-60-80°
- 3 different inclinations of the roof slopes: 10-20-30°



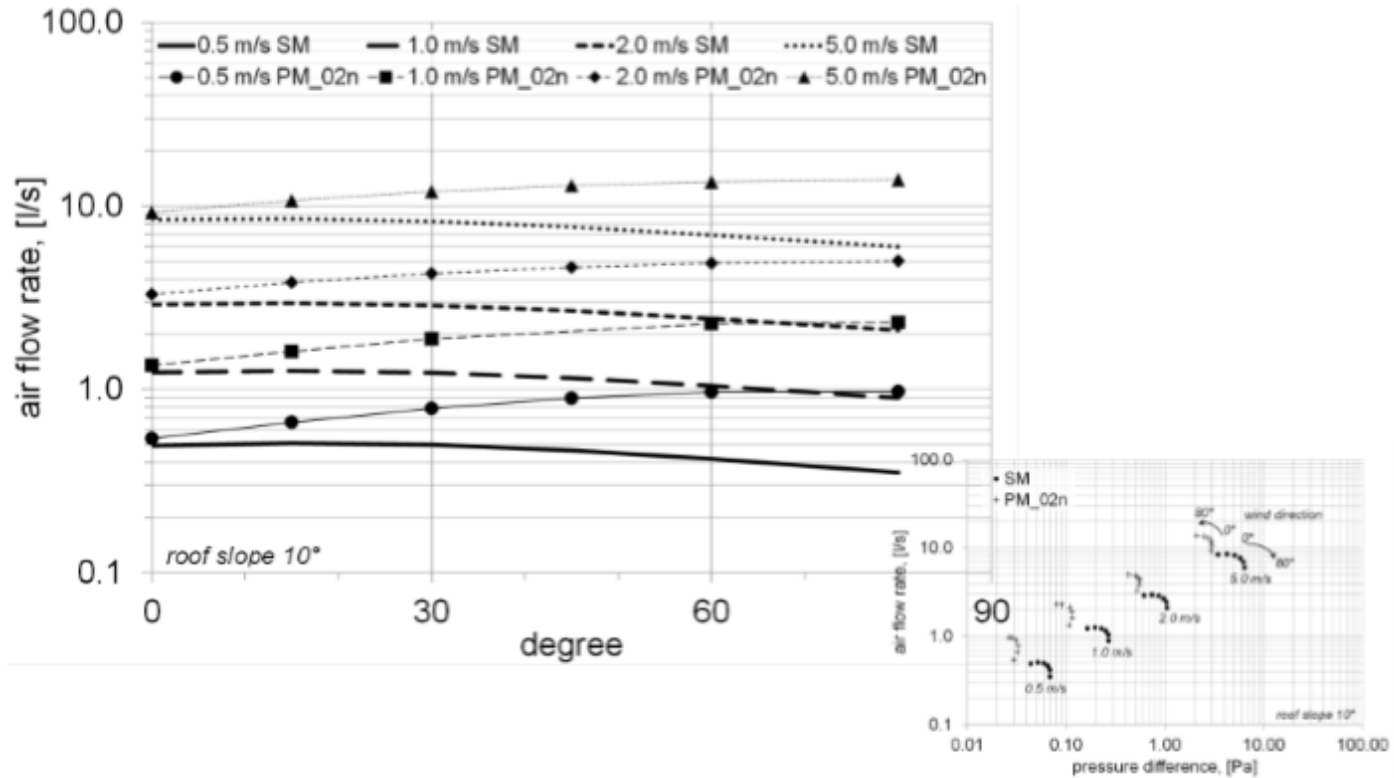
$$\begin{cases} u = i \cdot \cos(\alpha) \cdot \cos(\beta) \\ v = i \cdot \cos(\alpha) \cdot \sin(\beta) \\ w = -i \cdot \sin(\alpha) \end{cases}$$



ACTION A1



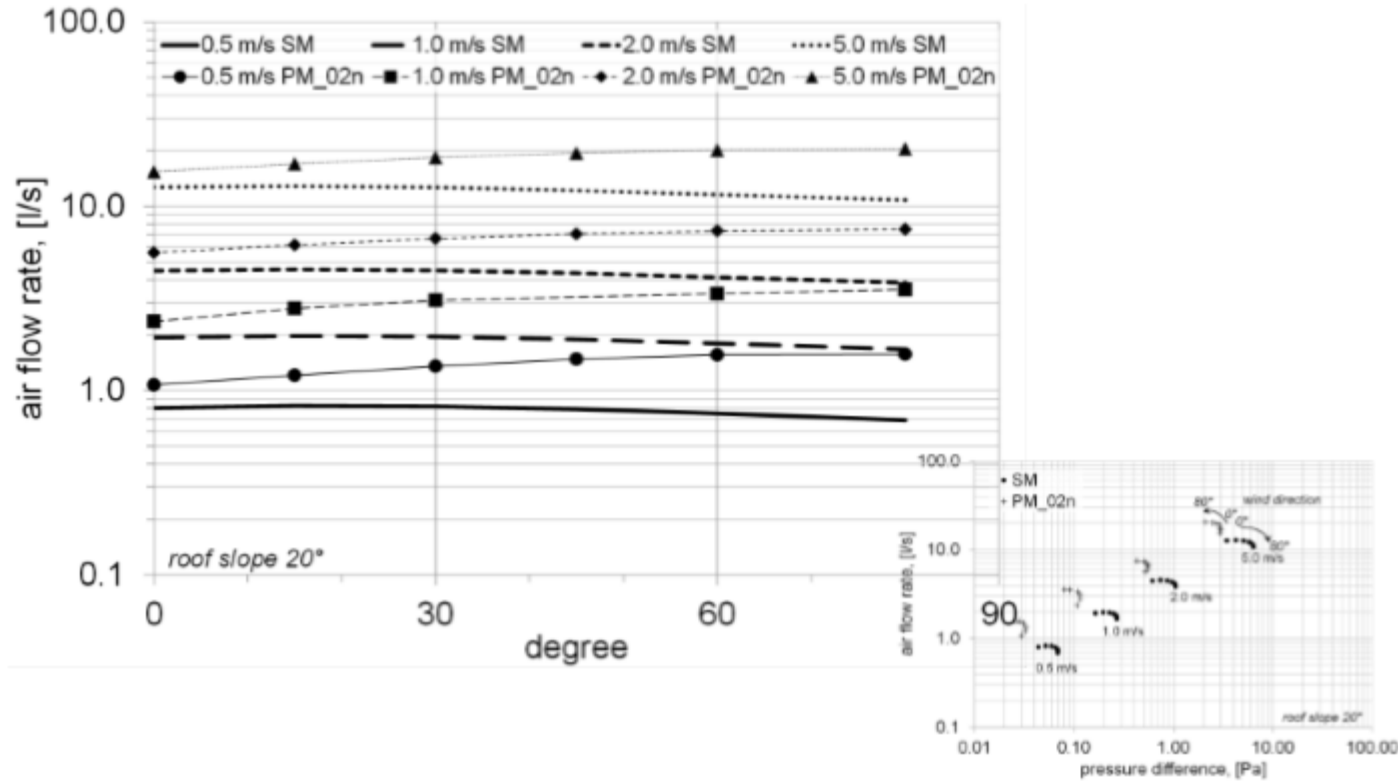
Results – tilt 10°



ACTION A1



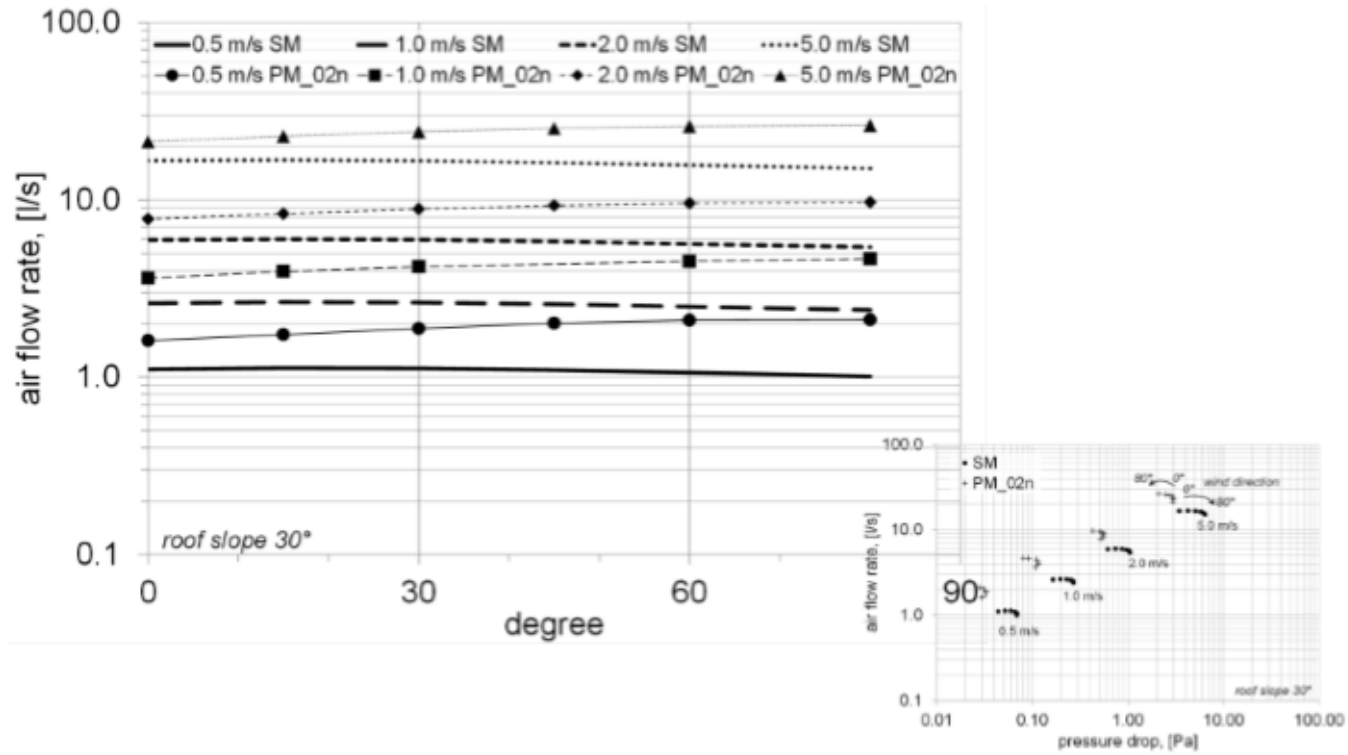
Results – tilt 20°



ACTION A1



Results – tilt 30°



ACTION C2 FIRST RESULTS



ACTION C2 FIRST RESULTS



ACTION C2 FIRST RESULTS



ACTION C3



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ACTION C3



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YERUCHAM



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ACTION C3 FIRST RESULTS - FERRARA



Room	Type	Roof	MWh
F2	Portuguese Tile STANDARD	pitched	0,097
F3	Portuguese Tile HEROTILE	pitched	0,080
F5	Marseille Tile STANDARD	pitched	0,093
F6	Metal	pitched	0,147
P2	Flat	flat	0,260

ACTION C3 FIRST RESULTS - YERUHAM

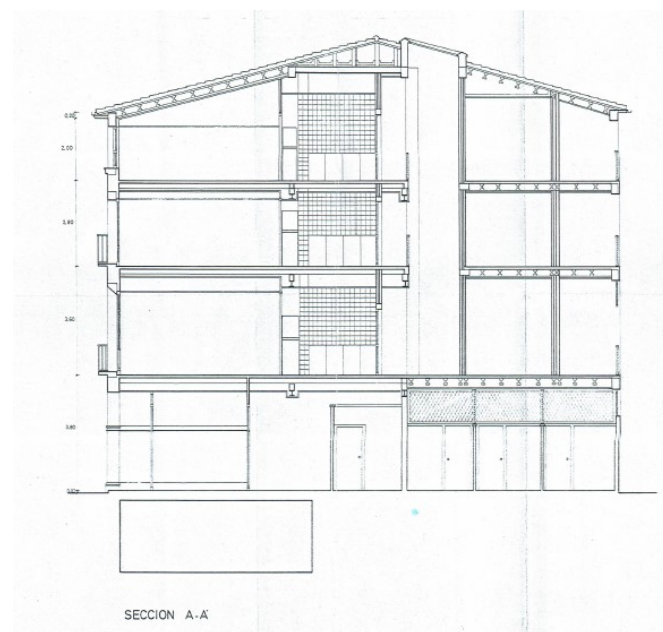


Room	Type	Roof	kWh / m ³
A1	Ventilated HEROTILE and Unventilated Portuguese Tile	pitched	1,08
A2	Unventilated metal cover and Ventilated portuguese tile standard	pitched	1,34
B	Flat	flat	2,77

ACTION C4



Area de Rehabilitación Urbana y Proyectos de Innovación Residencial Sociedad Municipal Zaragoza Vivienda, S.L.U



ACTION C5

SENSAPIRO (Software Energy SAVings PItched Roof)



MEETING IN UNIVERSITY OF FERRARA FOR SOFTWARE REQUIREMENTS SPECIFICATION 14/03/2017



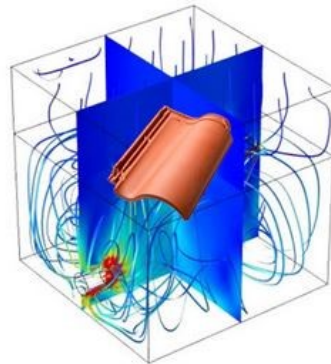
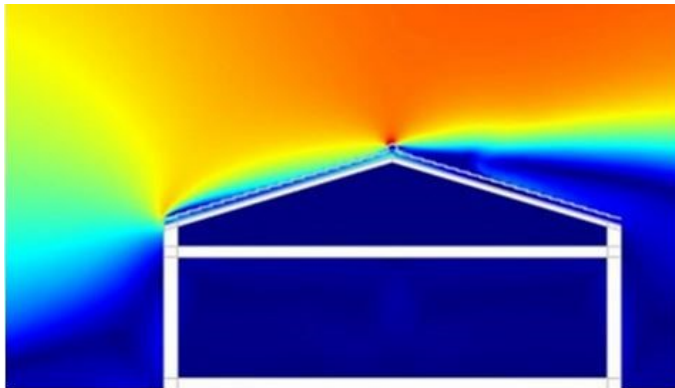
EXPECTED IMPACTS



Consider that the two types of roofing tiles to be re-designed and produced into the pilot plants cover more than the 60% of the European pitched roofs.

Life Herotile will cover a good share of market, above all in the countries of the Mediterranean area, with 130 millions of inhabitants in the South of the Europe, which correspond to almost **5,2 billion square meters of roof surface**.

In the 2018 , Industrie Cotto Possagno will be the first Company in Europe which will have a **Portuguese roofing tile highly breathable, certified with the new European EPD parameters, also in the reflecting version**.



ACTION E2 NETWORKING



KICK OFF MEETING 6th November 2015

Organised by EASME (European Agency for Small and Medium Enterprises)

www.neemo.eu



ACTION E1 EXAMPLE OF EVENTS



September 2016

TECHNICAL TRIP

Study Visit at LIFE HEROTILE mock-up building



ACTION E1 EXAMPLE OF EVENTS



TRADE FAIR KLIMAHOUSE

Bolzano (BZ)

dal 26 al 29 gennaio 2017



January 2017

ACTION F2 PROJECT MANAGEMENT



3RD TECHNICAL MEETING



23-24 gennaio 2017

January 2017

**ACTION E1
EXAMPLE OF EVENTS**



SEMINAR

LIFE HEROTILE METHODOLOGY EXPLAINED TO UNIFE STUDENTS



March 2017

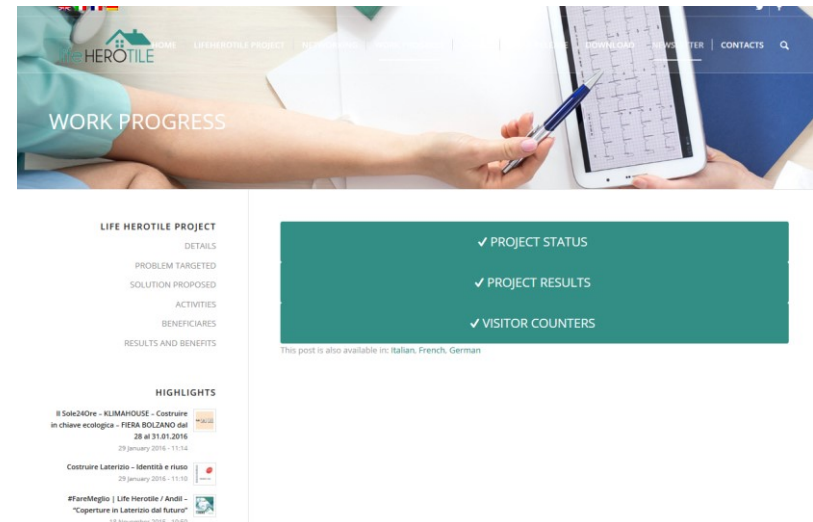
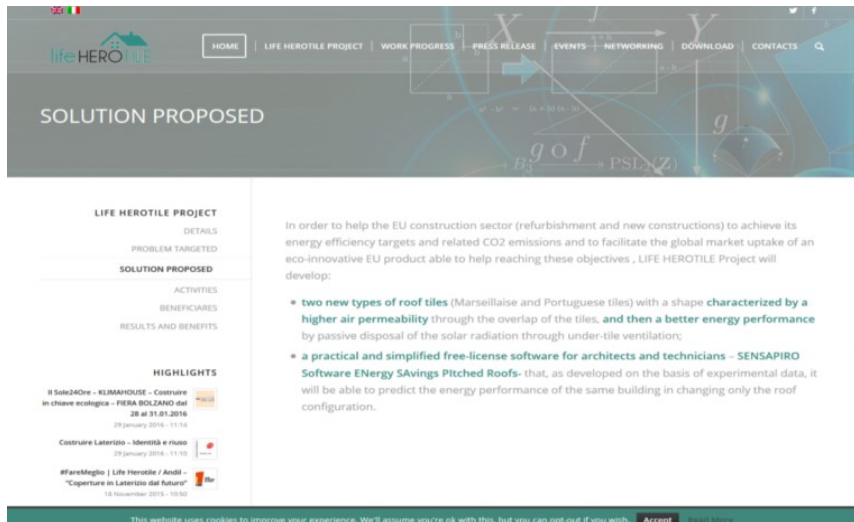
ACTION E1 WEB SITE



<http://www.lifeherotile.eu/>

It is possible to register into the website to be updated with the latest news on research

<http://www.lifeherotile.eu/>



UN RINGRAZIAMENTO PER IL CONTINUO SUPPORTO PROFESSIONALE ED AMMINISTRATIVO ALLA WARRANT GROUP

e

GRAZIE PER L'ATTENZIONE

Per ulteriori informazioni:



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