Ongoing R&D projects in COST member countries

January 2014

ITALY

COST FP1303: Performance of bio-based building materials

Italy

January 2014

COST FP1303 Participating Groups in Italy:

- CNR-IVALSA (San Michele)
- CNR-IVALSA (Florence)

Other research groups potencially interesting in the Action:

- University of Trento
- CATAS
- University of Torino

Industries potentially interesting in the Action:

- CORMO
- Rubner
- Alpi
- numerous SME dealing with wood construction in Italy

Country
Research institute/uni/company

January 2014

Participating Group 1: CNR-IVALSA (San Michele)

Jakub Sandak: *wood technology, IT, experimental design, (MC member)*
Anna Sandak: *biology, wood chemistry, spectroscopy*
Mariapaola Riggio: *architecture, historical timber structures, service life*
Ilaria Santoni: *chemistry, wood science*

Martino Negri: *Laboratory of wood quality and non-destructive testing*
Ottaviano Allegretti: *Laboratory of wood drying and thermal treatment*
Giovanna Bochicchio: *Fire laboratories*
Paolo Simeone: *Wood building design lab*
Nadia Gaeti: *Windows and curtain walls laboratory*

R&D projects

January 2014

Ongoing research projects in relation to COST FP1303:

- SWORFISH (superb wood surface finishing)
- Made in Italy (development of model house based on Italian technologies)
- MAI (development of modular/mobile house according to CNR-IVALSA)
- TV4NEWOOD (technology for thermal wood modification in vacuum)

Historical research projects relevant to COST FP1303:

- Sofie (sustainable buildings)
- Valerie (fire risk assessment model)

Please find more details in: http://www.ivalsa.cnr.it/en/current-projects.html

Country
Research institute/uni/company

January 2014

Participating Group 2 CNR-IVALSA (Florence)

***Sabrina Palanti**: Wood biodegradation and preservation laboratory.*
***Michela Nocetti:** Laboratory of physical and mechanical test.*
***Michele Brunetti**: Laboratory of physical and mechanical test.*
***Benedetto Pizzo:** Laboratory of chemistry of wood and wood products.*
***Nicola Macchioni:** Laboratory of Wood Anatomy.*

Specialist equipment

January 2014

Laboratory of Surface Characterization at CNR-IVALSA (San Michele)

responsible; ***Anna Sandak*** *(anna.sandak@ivalsa.cnr.it)*

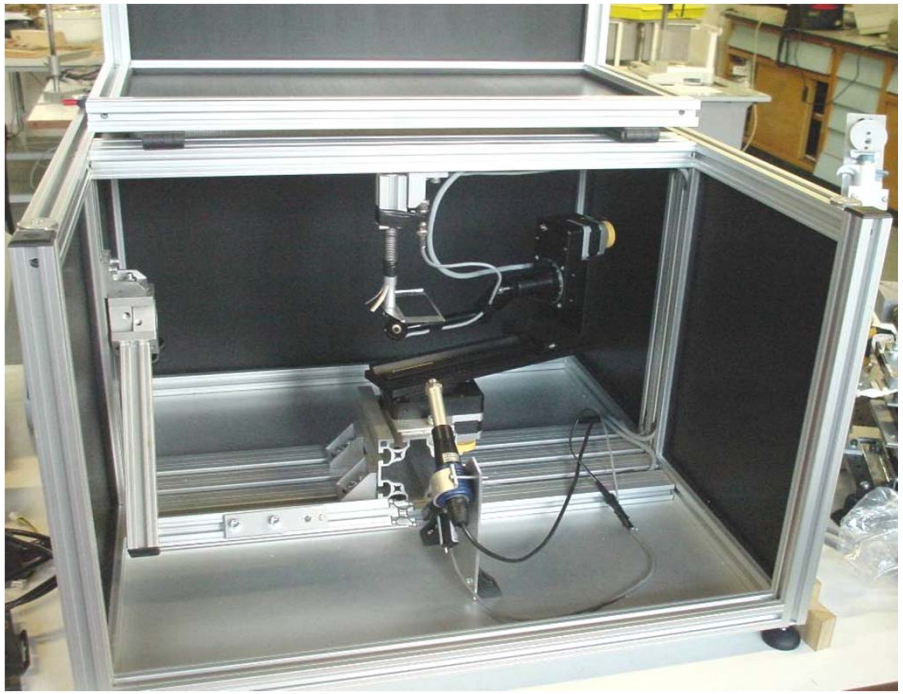
1. Characterization of wood surfaces

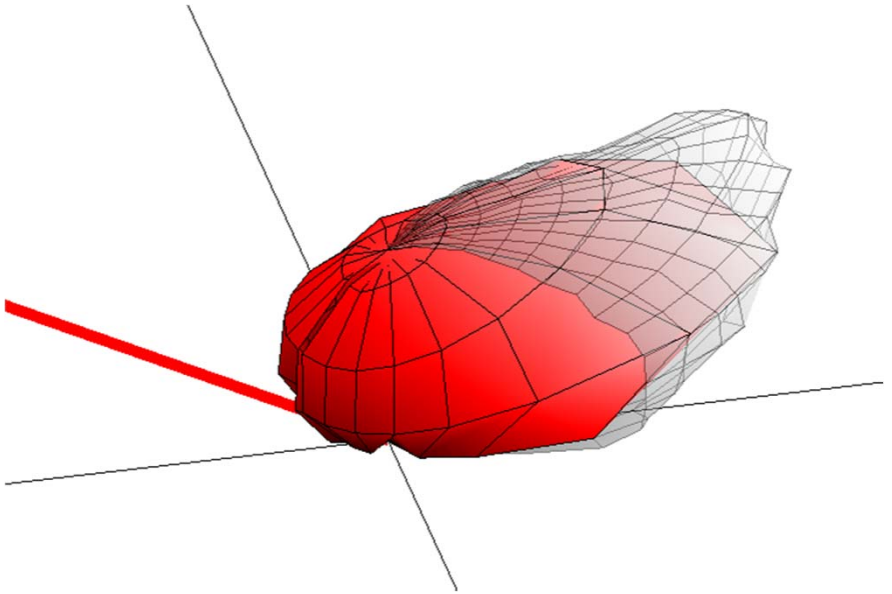
The Laboratory is equipped with an integrated set of commercial and prototype instruments for the determination of the surface properties of wood at the various structural scales
(from the nano to the macroscale), among others:

- *near infrared spectra*
- *mid infrared spectra*
- *surface color*
- *pattern*
- *surface roughness*
- *surface gloss*
- *wettability*
- *microscopic analysis*
- *hygroscopic properties*

http://www.ivalsa.cnr.it/en/laboratories/laboratorio-per-la-caratterizzazione-delle-superfici.html

goniometer; 3D gloss scanner



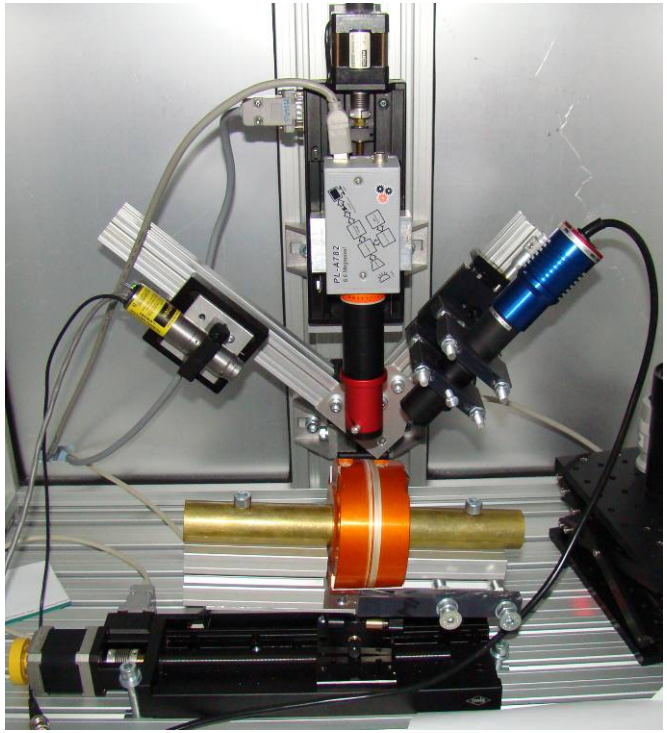


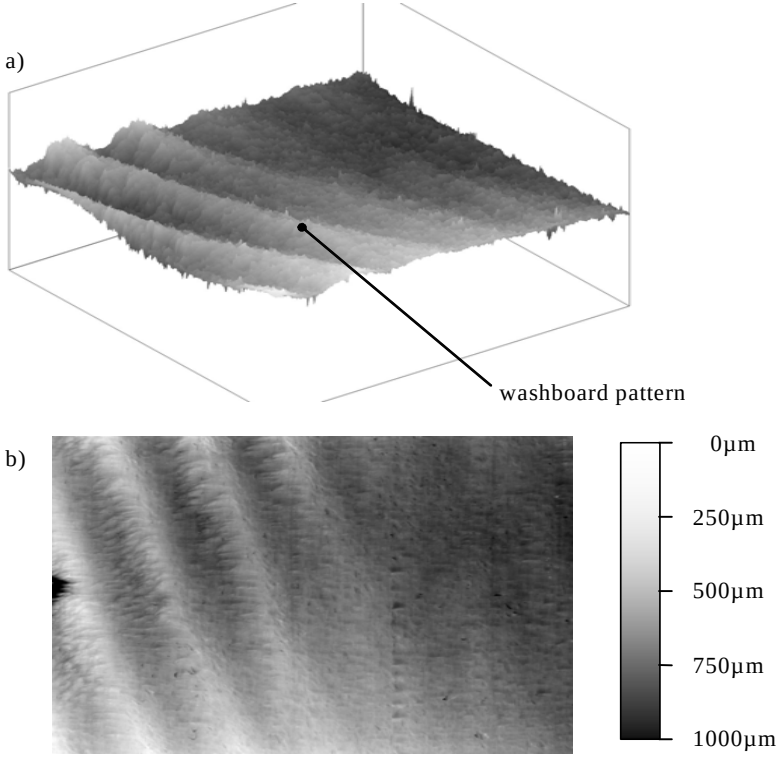
Technique description

One of the most important, but sometimes underestimated properties of the surface is the light reflectance or gloss. In general there are three types of interactions when light hits a surface: reflection, absorption, transmittance.

The light interaction with wood is especially complex therefore the standard techniques of the reflectance measurement with gloss-meter are very limited. The alternative is: instead of measuring only one direction of the light reflection, measure the whole sphere. It is known from literature as Bi-Directional Reflectance Function (BDRF). For estimation of the BDRF custom gonioreflectometer has been developed at IVALSA/CNR. The quantity and quality of information is superior to the standard gloss-meters, but in the same time the algorithm for data processing is much more complex. It is rather difficult to present the reflectance type by one numerical expression, therefore some simple and intuitive algorithms for computation of the numerical indicators (calculated on the base of BDRF) are developed.

profilometer; 3D roughness scanner

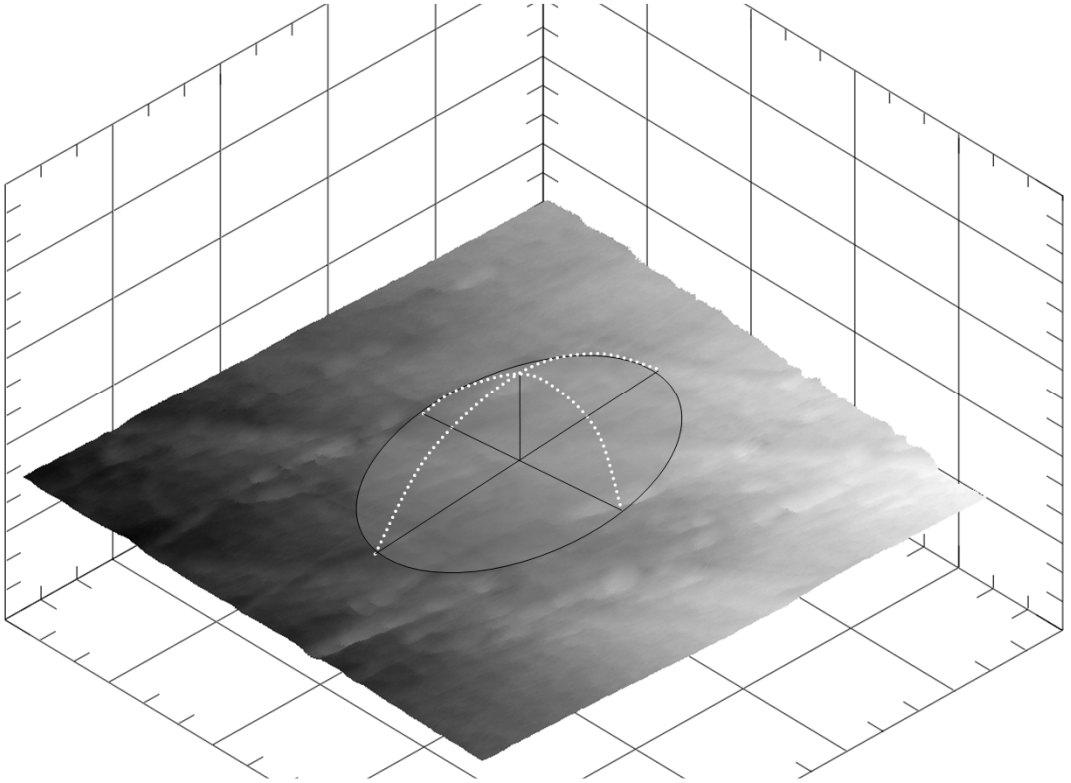




Technique description

Measurement of surface topography is traditionally performed be means of the contact stylus. Such method has important limitations (tip pressure, radius of the tip, concave angle and possibility of plastic deformations of surface). The alternative might be optical methods, including triangulation. The device is an experimental platform suitable for testing different source of light, detection optics and image processing algorithms.

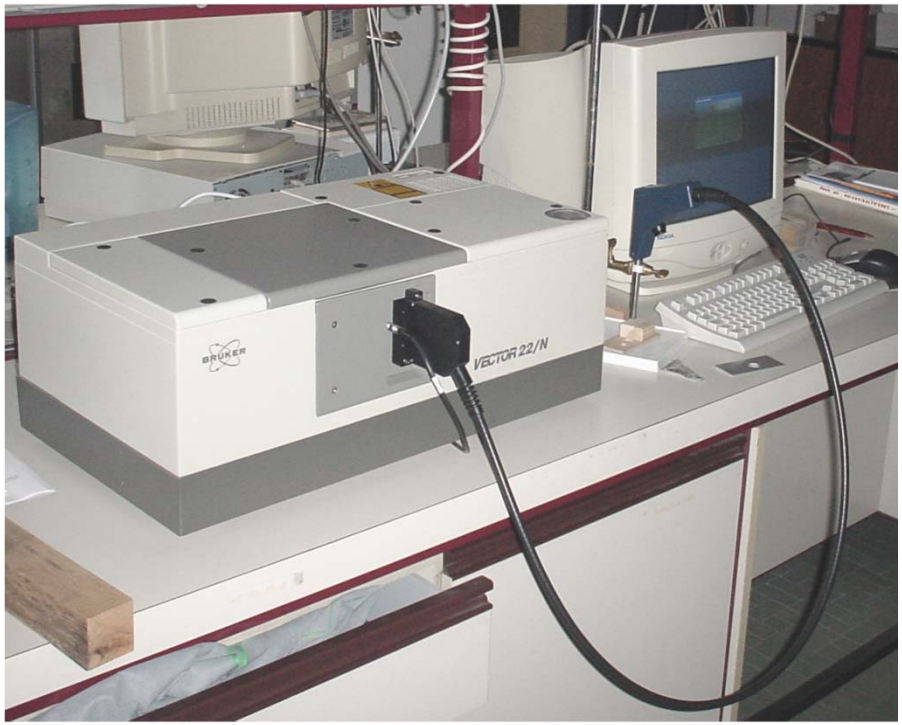
Tensionmeter; 3D sessile drop scanner

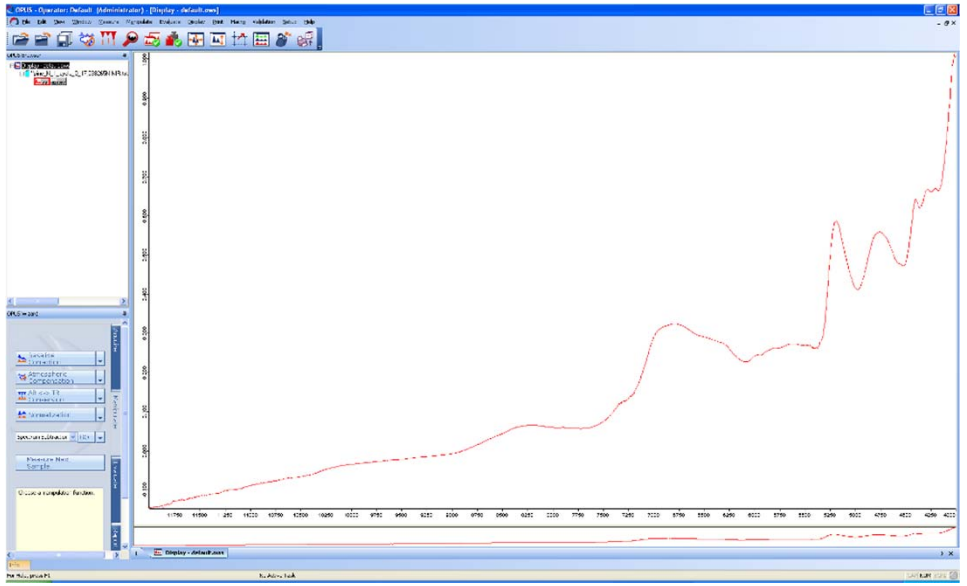


Technique description

Wetability is very important indicator of physical-chemical properties of surface, especially wood. The measurement of the sessile drop immersing the surface is one of the most common techniques for determination of the contact angle. It possesses however several important limitations, especially when evaluating wood surfaces (chemical heterogeneity, excessive surface roughness, porosity, among others). The solution of IVALSA/CNR is to measure the overall shape of the drop (instead of only one contour) and, on this base, to compute the range of contact angles. Moreover additional sensors are employed in order to measure the surface topography. It is also possible to include a precise balance for measurement of the combined weight of sample and liquid (in order to estimate the evaporation ratio and/or liquid absorption).

FT Near Infrared Spectrometer



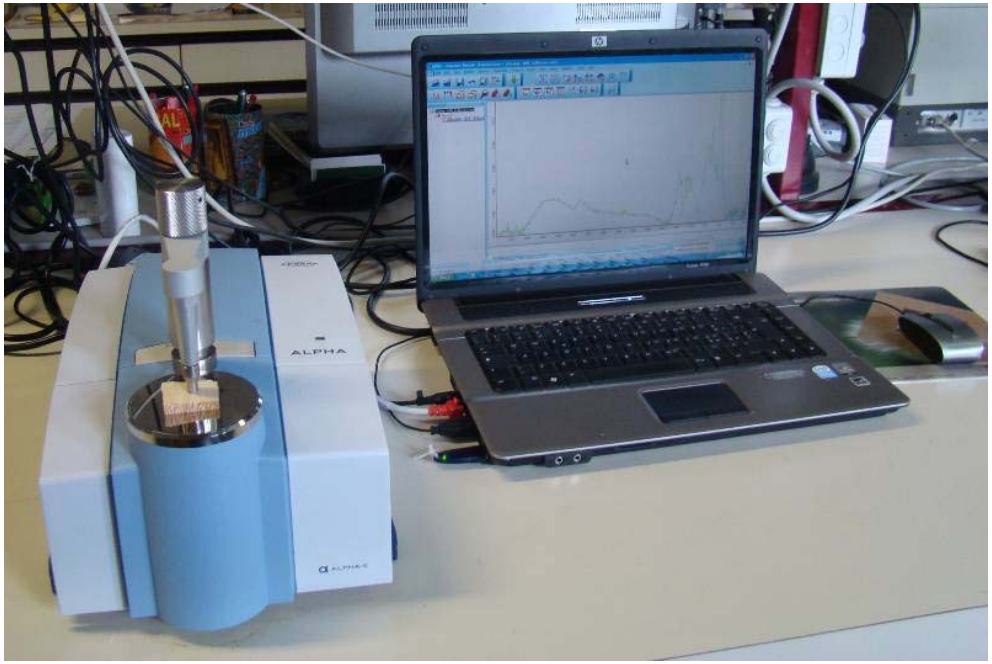


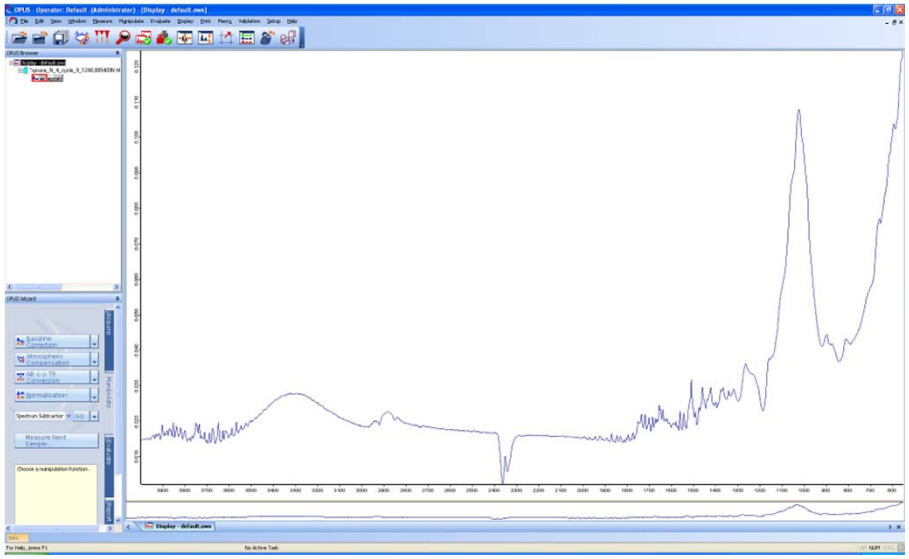
Technique description

Near infrared spectroscopy is an analytical method based on the optical interferometry. The modulated infrared light is emitted to the object and part of the light reflected/transmitted is acquired by the system in the form of interferogram. By applying the Fourier Transform it is possible to obtain the spectra.

As the infrared energy absorption by molecules is very selective and proportional to the quality of functional groups excited, it is possible to interpret the spectra linking it to selected material properties.

FT Mid Infrared Spectrometer





Technique description

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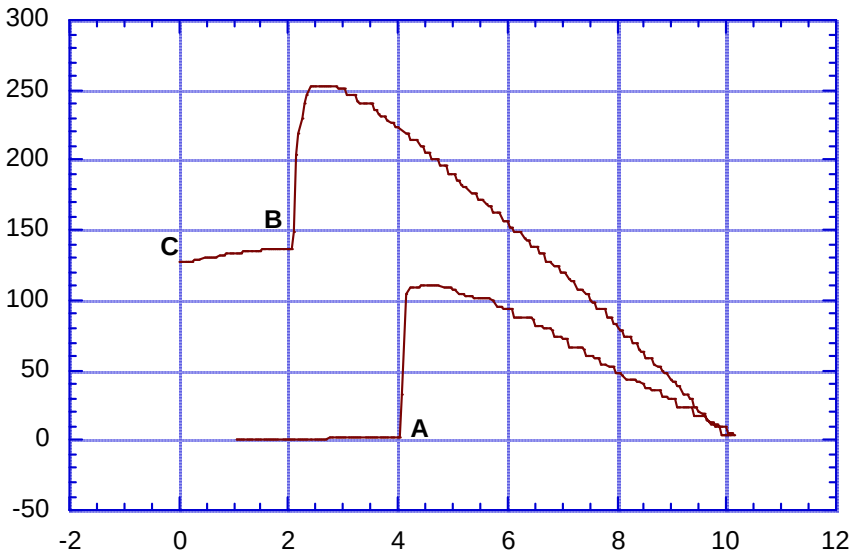
Tensionmeter

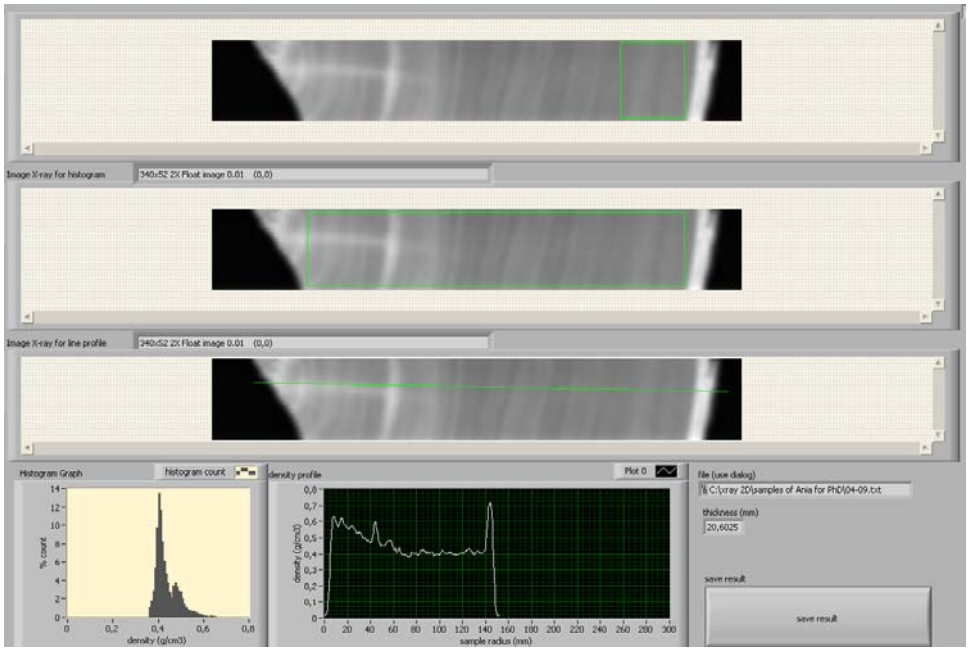


Technique description

Wetability is a very important indicator of physical-chemical properties of surface, especially wood. In the Willhelmy method the weight of the sample during immersion in liquid(s) of known physical properties (density, surface energy, viscosity, etc) is recorded in a function of the immersion depth. The weight is a superposition of the sample mass, buoyancy and interfacial interactions. By proper analysis of the wetting curves it is possible to estimate dynamic contact angle and/or surface free energy of the sample.

Due to the complex structure of wood surface (chemical anisotropy, porous, hydrophilic and rough nature) the signal processing of immersion (wetting) curve is very difficult, therefore several custom algorithms for signal processing have been developed.

X-ray densitometer



Technique description

By assuming that the x-ray attenuation coefficients of wood and water are the same it is possible to link the x-ray attenuation to matter (wood) density. It is important however to control the sample thickness and provide this data for computation.

Specialist equipment

January 2014

Laboratory of Surface Characterization at CNR-IVALSA (San Michele)

responsible; ***Anna Sandak*** *(anna.sandak@ivalsa.cnr.it)*

2. Surface treatments

- *surface coating techniques, including painting, spraying and immersing*
- *other techniques in collaboration with other IVALSA Labs:*
  - *drying and thermal treatment in vacuum kiln*
  - *thermo-mechanical modification*
  - *surface smoothening*
  - *mechanical processing*

3. Natural and artificial weathering tests

- *long-term natural weathering facilities*
- *artificial weathering machines:*
  - *QUV*
  - *Suntest*
  - *Custom machine composed of two chambers simulating "summer" and "winter"*

Specialist equipment

January 2014

Laboratory of wood quality and non-destructive testing at CNR-IVALSA

responsible; ***Martino Negri*** *(negri@ivalsa.cnr.it)*

1. ***Measurement platform for solid wood and sawn timber***
2. ***Measurement platform for veneers and wood surfaces***
3. ***Measurement platform for wood-based panels and acoustic boards***
4. ***Measurement platform for biomasses***

Examples of avaliable equipment:

- *Measurement system(s) for density and basic density*
- *Laboratory X-ray densitometer and small size samples CT*
- *Two axis Laser Micrometer for shrinkage and swelling on cylindrical specimens*
- *Fessures measurment device for veneers*
- *Acoustic characterisation system(s); microphone array and laser XY modal analysis device*
- *Spectrofotometers (400-700 nm)*
- *Reconfigurable mechanical testing machines (20 kN) + accessories (vision, thermovision, NIR, acoustic)*
- *Non-destructive testing BING, Sylvatest, Arborsonic, Pydodin*
- *Recyclability and heavy metals measurements with X-ray fluorescence*

http://www.ivalsa.cnr.it/en/laboratories/wood-quality-and-non-destructive-testing.html

Specialist equipment

January 2014

Laboratory for windows and curtain walls at CNR-IVALSA

responsible; ***Nadia Gaeti*** *(gaeti@ivalsa.cnr.it)*

Main equipment

- *Test device for air permeability, water tightness, resistance to wind loads on windows and on curtain walls*
- *computerized device for repeated opening and closing and for mechanical stability determination*
- *Test frame for burglar-resistance determination, for mechanical and dimesional tests*
- *Thermal transmittance software*

Test and certification activity (UNI-EN) both in the lab and in-situ

- *VERIFICATION OF RESISTANCE TO WEATHER CONDITIONS*
- *windows and doors; air permeability, water tightness, wind load*

- *BURGLAR RESISTANCE EVALUATION*
- *windows, doors, shutters; Burgla resistance: resistance under static loading, resistance under dynamic loading*

- *OPERATING FORCES TESTS*
- *Windows, doors; determination of the resistance to racking, determination of the resistance to static torsion, operating forces, soft and heavy body impact, operating forces measurements*

- *DURABILITY OF THE WINDOWS*
- *Windows and doors; Resistance to repeated opening and closing*

- *THERMAL CHARACTERIZATION*
- *Thermal performance of windows, doors and shutters; Calculation of thermal transmittance*

http://www.ivalsa.cnr.it/en/laboratories/windows-and-curtain-walls-laboratory.html

Fire laboratories – IVALSA

Tecnical Director: dott.ssa Giovanna Bochicchio

Reaction to fire Laboratory

The reaction to fire assess the contribution of a product o material exposed to fire in the early stages of a fire, in terms of "Heat release rate", "smooke production rate" and "flame spread

F L A S H O V E R

Resistance to fire Laboratories

The fire resistance is the ability of a construction element to withstand fire or give protection from it for a period of time. Typical criteria used to assess fire resistance:

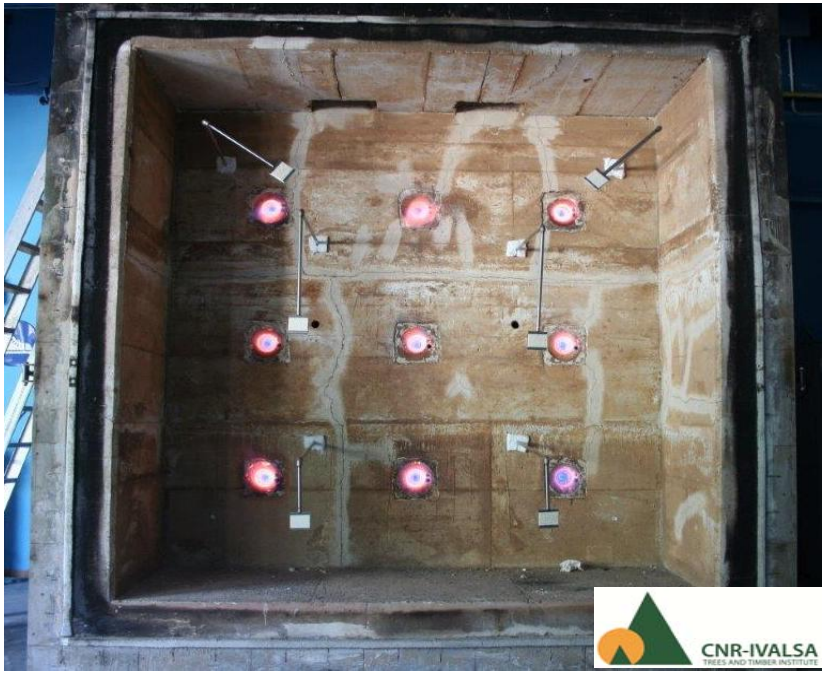
- Load capacity (R)
- Fire integrity (E)
- Thermal insulation (I)

RESULT OF THE TEST

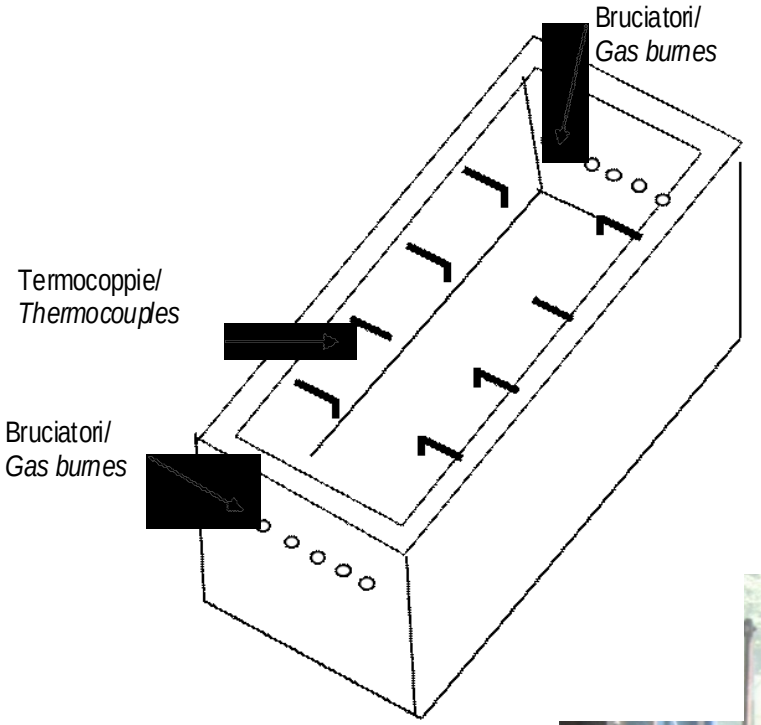
- Internal and external temperature
- Vertical contraction
- Horizonthal deflections
- Irradiance

Laboratory Resitance to Fire– Vertical Furnace

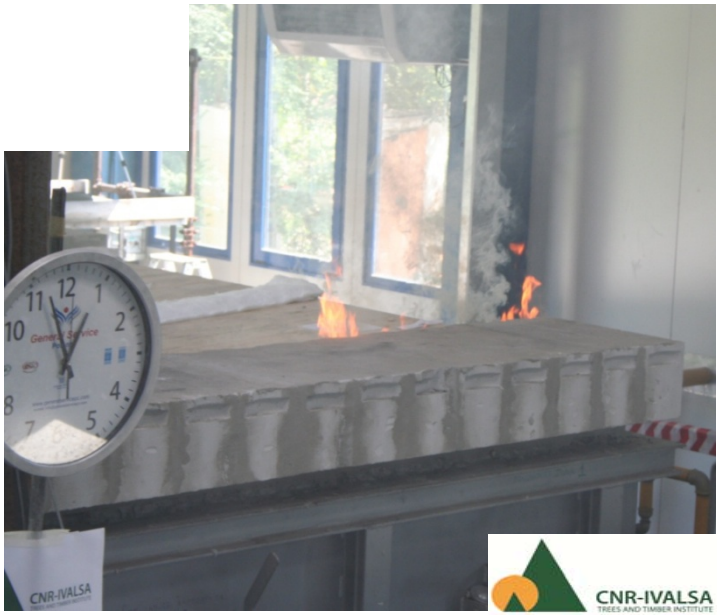
We test vertical elements, non-loadbearing walls, loadbearing walls and doors



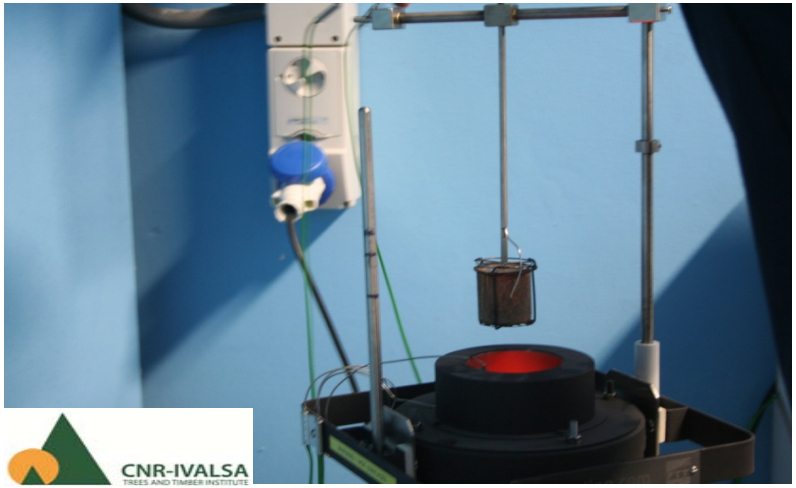
Laboratory Resitance to Fire – Horizonthal Furnace

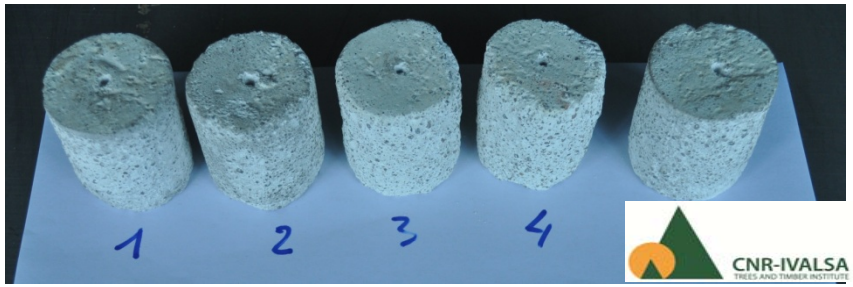


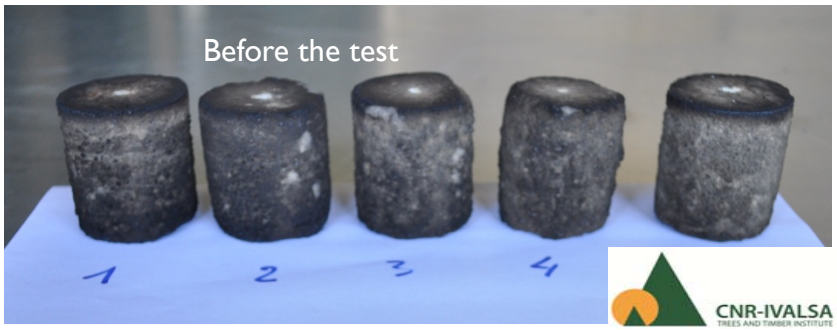
We test horizontal elements, non-loadbearing floors, and loadbearing floors



Laboratory Reaction to Fire – Furnace for non-combustibility test

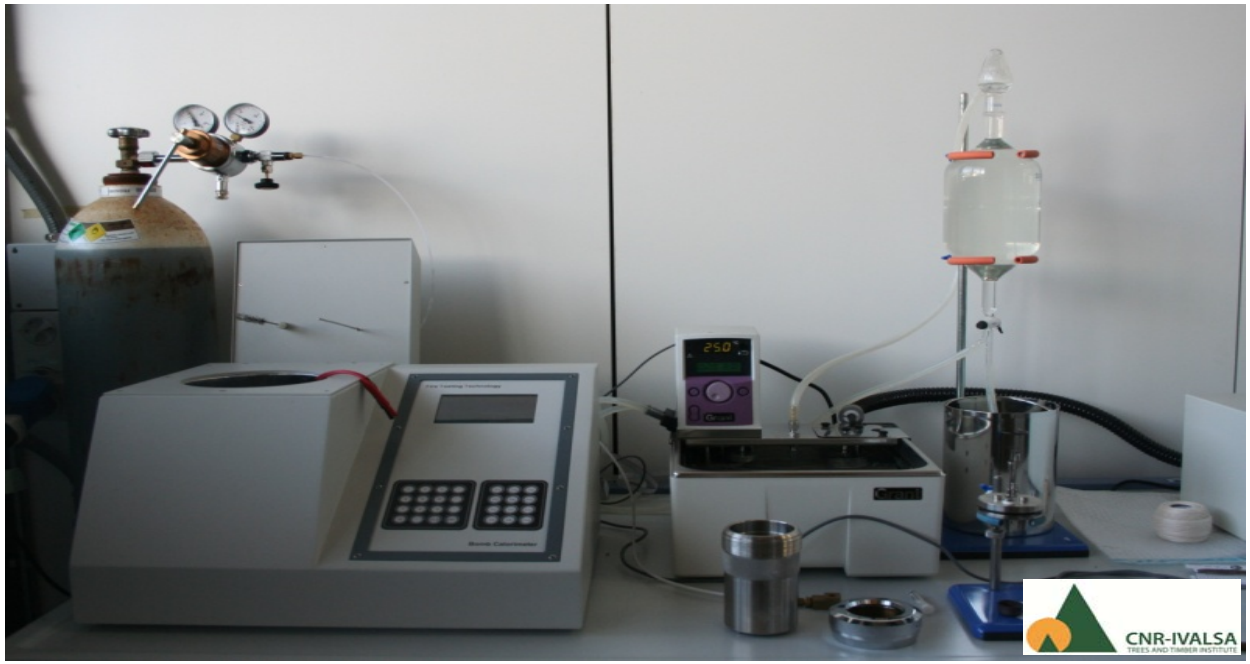






We assess:
- sustained flaming
- mass loss
- temperature rise in the furnace

Laboratory Reaction to Fire – Bomb Calorimeter



We assess the heat of combustion.

Barbara Tessadri

Laboratory Reaction to Fire – Single burn item

Results:
As a function of O2 consumption and CO2 production the apparatus determines:

⇨ HRR : heat rate release (kW)

⇨THR600s: total heat release of the specimen in the first 600 s (MJ)

⇨ FIGRA (fire growth rate indice) in W/s:

⇨ LSF: propagazione laterale della fiamma

⇨ SPR: smooke production rate (m^2/s)

⇨TSP_{600s} :Total smooke production in the first 600 s (m^2)

⇨ SMOGRA: smoke growth rate index (m^2/s^2)

Laboratory Reaction to Fire – Combustion chamber for Single-flame source test

Before the test

We asses:
- whether ignition occurs;
- whether the flame tip reaches 150 mm above the flame application point;
-presence of flaming droplets/particles;
--observations of physical behaviour of the test specimen

After the test

Laboratory Reaction to Fire – Radial Panel

The imposed radiant flux simulates the thermal radiation levels likely to impinge on the floor of a corridor whose upper surfaces are heated by flames or hot gases or both, during the early stages of a developing fire in an adjacent room or compartment under wind-opposed flame-spread conditions.

We observe/measure:
-at 10 min intervals from the start of the test and at the flame-out time, the distances between the flame front and the zero point
-any significant phenomena such as transitory flaming, melting, blistering, time and location of glowing combustion after flame-out
-penetration of the flame through to the substrate, etc.
fusione e formazione di bolle
- Smooke production rate

Laboratory Reaction to Fire – Cone Calorimeter

We assess the:

-heat release rate (HHR)

-dynamic **smoke production rate (SPR)**

- time to ignition (tig)

- mass flow rate (MFR)

of specimen exposed in the horizontal orientation to controlled levels of irradiance with an external igniter.

Laboratory Reaction to Fire – ROOM CORNER TEST

Test method that simulates a fire that originated in a corner of the room, under conditions of ventilation secured by the opening of a door.

Parameter:

- total heat flux incident on the heat flyux meter

  located on the centre of the floor

- heat rate releas (HRR)

- total heat release (THR)

- smooke produxction rate (SPR)

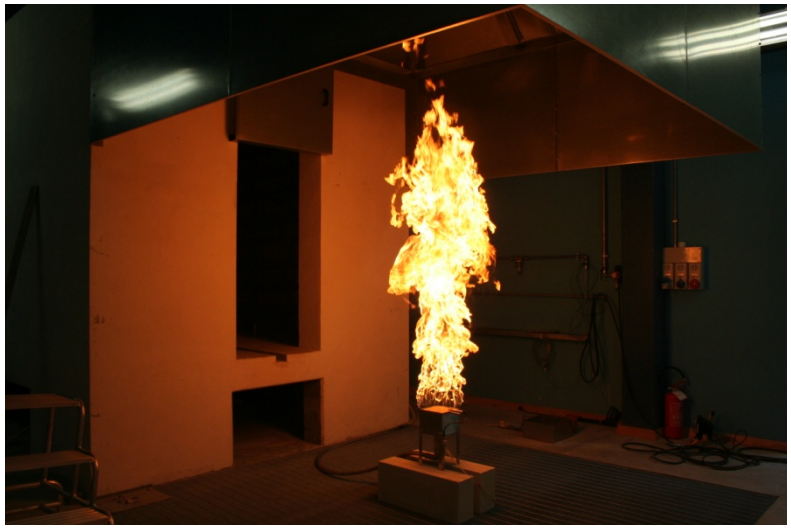
Laboratory Reaction to Fire – NT FIRE 032

NT fire 032.

This method is intended to be used for the evaluation of fire behaviour of upholstered furniture in full scale. The specimen is ignited by a specified ignition source and burns freely under well ventilated conditions.

Results:

Heat rate release
Smooke productuion rate
Mass loss rate



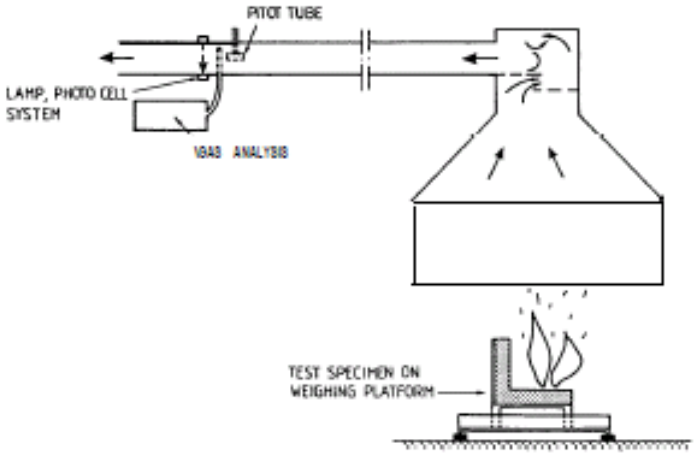


Fig. 1. Test configuration.

Specialist equipment

January 2014

Laboratory of wood biodegradation and preservation (responsible Sabrina Palanti)

-2 Pilot plants for the Vacuum-Pressure-Temperature treatment of wood.

- Vertical Laminar Flow cabinet.

- Sterilization autoclave

- 2 Controlled temperature humidity rooms for conditioning of wood and for growing fungi and insects

-RX intrument

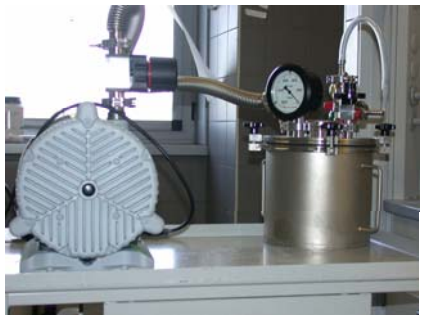
- <u>Ongoing project relevant to COST FP1303</u>:

Nanosolwood: Innovative treatments for consolidation and preservation of wood through hybrid nanosols. National agreement with University of Modena e Reggio Emilia, University of Parma, Renner Italia S.p.A.

<u>Previous project relevant to COST FP 1303:</u>

Treatments for enhancement of wood durability. Program agreement between Autonomous Province of Trento and IVALSA for sustainable construction.

Vacuum-pressure-temperature pilot plant 20 l



Vacuum-atmosheric pressure pilot plant 5 l

Controlled chamber for fungal test

Living collections of insects species

Specialist equipment

January 2014

Laboratory of chemistry of wood and wood products **(responsible Benedetto Pizzo)**

DMA (*Dynamic Mechanical Analysis*) test machine (*TA DMA Q800*)

FT-MIR Spectrometer with both transmittance and ATR (*Attenuated Total Reflectance*) device (*Bruker Alpha*)

UV-Visible Spectrophotometer (*Shimadzu UV-VIS 160*)

Horizontal pressing machine for wood gluing

Wood rotary mill and vibratory sieving machine for the granulometric separation of wood meal

Access to:

Gas-Chromatograph with Mass Spectrometer and automatic sampler (*Agilent GC 7820, Autosampler Gerstel, HS and DHS, SPME, Mass Spectrometer 5975C*)

Universal testing machine for mechanical tests (*Instron 5567*)

ESEM (*Environmental Scanning Electron Microscopy*) (*FEI Quanta 200*)

Previous project relevant to COST FP 1303

SOFIE 2 (a research project on sustainable buildings with the scope of defining the performance and the potential of a construction system for multi-storey buildings whose load-bearing elements are massive wood panels). Within the project: structural or semi-structural adhesives of biological origin; treatments for enhancement of wood durability for use class 3.

Specialist equipment

January 2014

The laboratory of wood anatomy

The laboratory aims to study and characterise, through the use of different microscopes, the anatomy of wood. Through the knowledge of the anatomical structure of a wood sample it can be determined the timber species and the state of preservation of the cells.

MAIN EQUIPMENT:
- Sliding microtome with freezing plate
- Digital optical microscopes
- Stereoscopes
- Xylarium
- SEM Philips XL 20
- Critical Point Dryer
- Gold coating system for SEM observations
- Image analysis systems
- Windendro applications
- Fiberscope
- 6.000 wood species xylarium

Staff:
Nicola Macchioni: head
Chiara Capretti: fixed-term researcher
Simona Lazzeri: technician
Lorena Sozzi: technician

Specialist equipment

January 2014

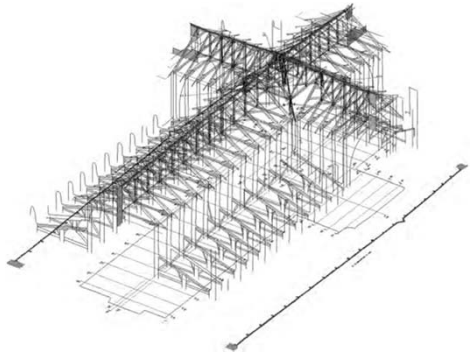
On-site diagnosis of timber structures

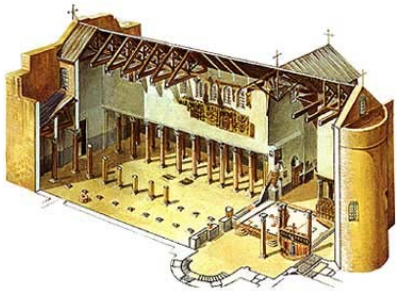
Aims:

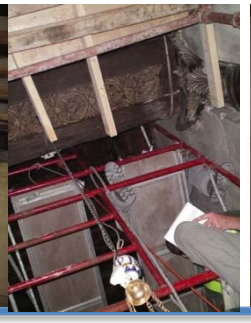
- Identification of structure types
- Diagnosis according to UNI 11119:2004

Cultural Heritage - Wooden artefacts - Load-bearing structures - On site inspections for the diagnosis of timber members

- Access to each element
- Defects evaluation to perform grading
- Moisture measurements
- Resistographic inspection







COST FP1303: Performance of bio-based building materials

Specialist equipment

January 2014

The laboratory of physical and mechanical test

- Material testing machines (4)
- Autoclave for delamination/impregnation (180 l; 0-12 bar)
- Climatic chamber (2000 l; T -20/+120°C)
- Precision balances
- Forced air ovens
- Gauges
- Transducers
- Electrical hygrometers
- Portable grading machine

Specialist equipment

January 2014

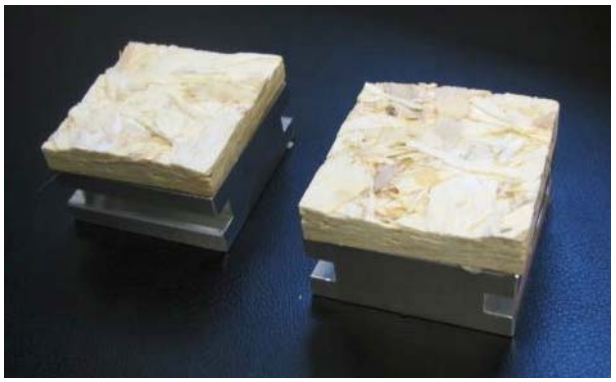
The laboratory of physical and mechanical test: activities

WOOD IN CONSTRUCTION

- Strength grading of wooden elements
- Characterizations and improvement of new structural products

WOOD QUALITY

- genetics and wood quality



Ongoing research projects in relation to COST FP1303

•Development of portable grading machine, suitable for local non-standard timber (Aprofomo)

•Producing cross laminated timber by low quality raw material (Edenso)

Specialist equipment

January 2014

institute	properties						environmental					laboratory tests						field tests				
	natural durability	moisture/sorption studies	resistance to mould	fire resistance/reaction to fire	insects/termites/pests	dimensional stability	life cycles assesment	whole life evaluations	product accreditation	emission testing	environmental product declaration	natural durability	mould resistance	insect/termite testing	leaching/weathering	sorption studies	dimentional stability	inground contact tests	out of ground contact tests	natural weathering	surface performance/coatings	moisture data logging
CNR-IVALSA San Michele	X	X		X		X	X		X	X		X			X	X	X			X	X	X
CNR-IVALSA Firenze	X				X							X		X	X			X	X			