Project Development:
Residential Building

THERMAL CHARACTERISTICS OF MATERIALS

Municipality	**ROME**
Address	
Contractor	**Mr ROSSI**
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Annexes:

1. Thermal, hygrometric and surface mass characteristics of the opaque vertical structures of the building's shell.
2. Thermal, hygrometric and surface mass characteristics of the opaque horizontal structures of the building's shell.
3. Thermal transmission of the partition elements between the residential units.
4. Thermal characteristics of the window components of the building.
5. Calculation of the surface temperature and of the interstitial condensation of the building structure according to the norm UNI EN ISO 13788.

1) Thermal, hygrometric and surface mass characteristics of the opaque vertical structures of the building's shell.

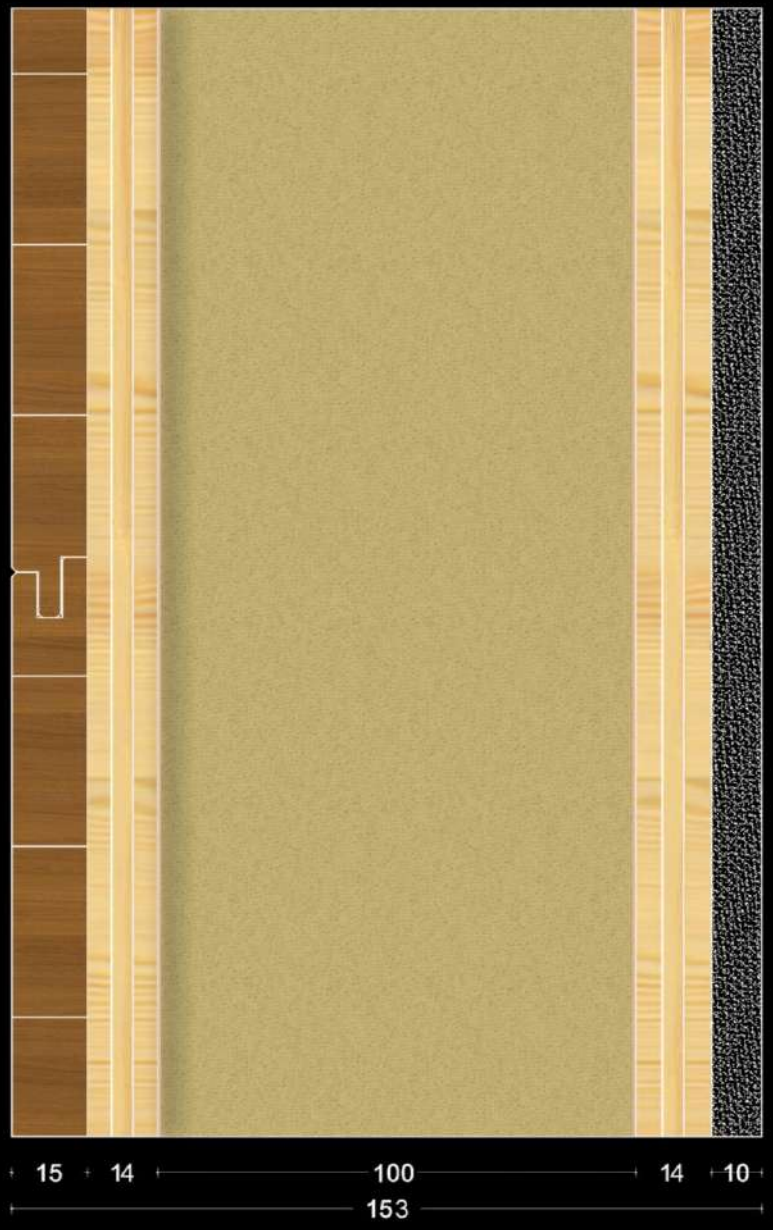
DEFINITION	SYMBOL	UNIT
Volumetric mass of the layer. Density.	**D**	[Kg/m³]
Thickness	**s**	[cm]
Indicative conductivity reference	**λ**	[W/(m·K)]
Conductivity calculation	**λ_m**	[W/(m·K)]
Increase percentile	**m**	[%]
Internal unit thermal resistance (opposite to the conductance)	**r**	[(m²·K)/W]
Temperature difference between the surfaces that delimit the layer	**dT**	[°C]
Surface temperature on the bottom of the layer	**Tf**	[°C]
Saturation pressure of the water vapour	**Ps**	[kPa]
Resistance of the vapour passage	**μ**	-
Resistance of the flux of vapour of the layer	**Rv**	[m²sPa/kg]
Pressure difference between the surfaces that delimit the layer	**dP**	[kPa]
Partial pressure of the water vapour	**Pv**	[kPa]
Superficial mass of the layer	**Ds**	[Kg/m²]
Mass and thermal capacity of the layer's material	**CT**	[kJ/(kg·K)]
Superficial thermal capacity of the layer times the unit variation of the room temperature	**CTs**	[kJ/m²]

STRATIGRAPHY – EXTERNAL PANEL																
Description of materials	**D**	**s**	**λ**	**m**	**λ_m**	**r**	**dT (*)**	**Tf**	**Ps**	**μ**	**Rv**	**dP**	**DS**	**Pv**	**CT**	**CTS**
Room air								20	2							
Internal surface layer						0,130	0,3	19,7	2							
Fermacell	1150	1			0,32	0,031	0,1	19,3	2,23	13	0,7	0	11,50	1,51	1,1	12,29
Agrop Swp 14 mm	490	1,4			0,13	0,108	0,3	19	2,18	60	4,5	0,03	6,86	1,47	1,6	10,55
Stiferite GT 100	36	10			0,023	4,348	10,9	8,2	1,08	150	80,0	0,55	3,60	0,92	1,453	2,74
Agrop Swp 14 mm	490	1,4			0,13	0,108	0,3	7,9	1,06	60	4,5	0,03	6,86	0,89	1,6	5,62
Iroko slats	710	1,5			0,18	0,083	0,2	7,7	1,04	60	4,8	0,03	10,65	0,85	2,4	12,88
External surface layer						0,040	0,1	7,6	1							
TOTAL:		**15,3**				**4,848**							**39,47**			**44,08**

Theoretic transmittance:	[W/(m²·K)]	0,206
Security increase (0[%]):	[W/(m²·K)]	0,206
Rounded number:		
Adopted transmittance:	[W/(m²·K)]	**0,206**

(*) The temperature differences in the various layers are obtained with a superficial internal thermal resistance of 0.25 [(m²·K)/W] as foreseen in table 2 in UNI EN ISO 13788.

COMPARISON WITH THE LIMIT VALUES		
Type of opaque structure	**:Vertical**	
Correct upper thermal transmission Uc	**:0,206**	[W/(m²·K)]
Limit value of the transmission	**:0,360**	[W/(m²·K)]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2) Thermal, hygrometric and surface mass characteristics of the opaque horizontal structures of the building's shell.

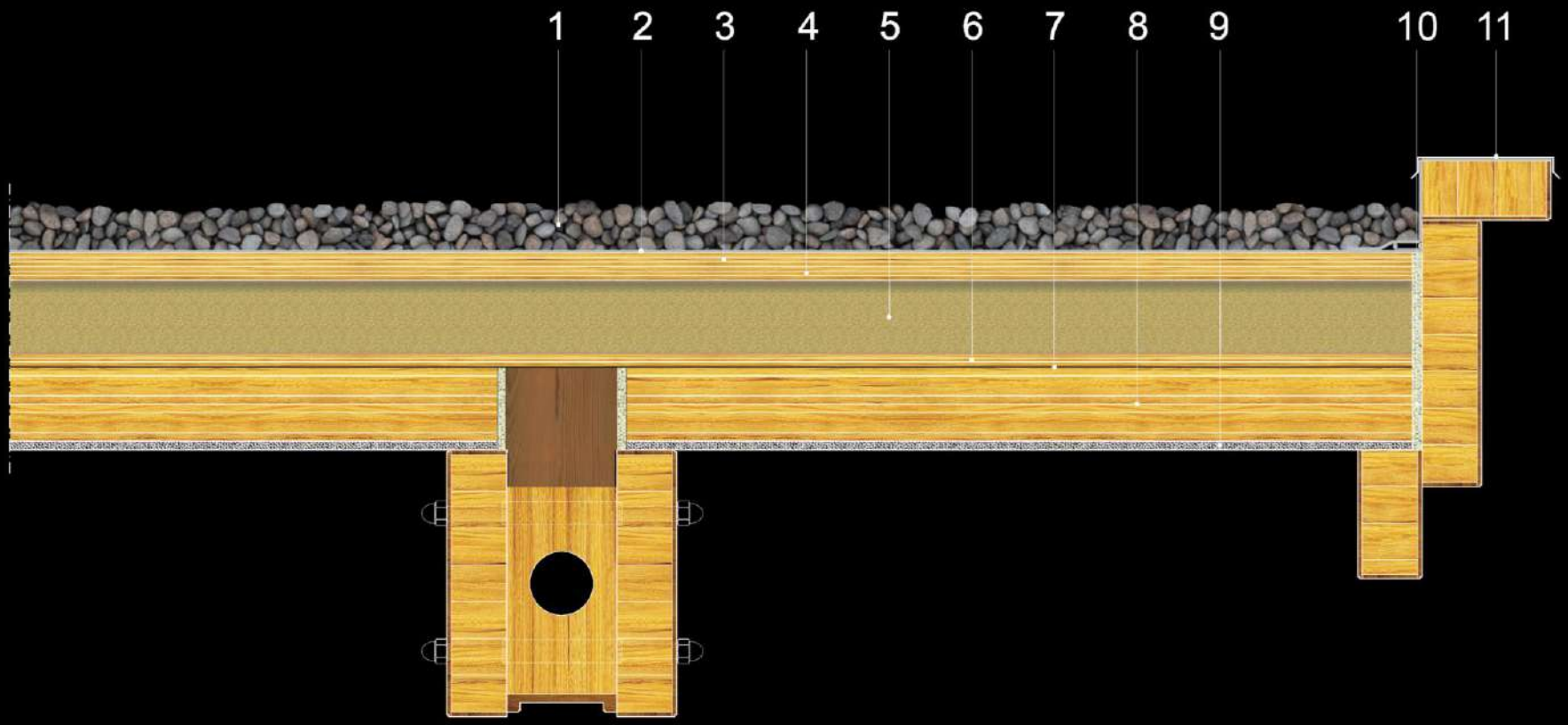
DEFINITION	SYMBOL	UNIT
Volumetric mass of the layer. Density.	**D**	[Kg/m³]
Thickness	**s**	[cm]
Indicative conductivity reference	**λ**	[W/(m·K)]
Conductivity calculation	**λ_m**	[W/(m·K)]
Increase percentile	**m**	[%]
Internal unit thermal resistance (opposite to the conductance)	**r**	[(m²·K)/W]
Temperature difference between the surfaces that delimit the layer	**dT**	[°C]
Surface temperature on the bottom of the layer	**Tf**	[°C]
Saturation pressure of the water vapour	**Ps**	[kPa]
Resistance of the vapour passage	**μ**	-
Resistance of the flux of vapour of the layer	**Rv**	[m²sPa/kg]
Pressure difference between the surfaces that delimit the layer	**dP**	[kPa]
Partial pressure of the water vapour	**Pv**	[kPa]
Superficial mass of the layer	**Ds**	[kg/m²]
Mass and thermal capacity of the layer's material	**CT**	[kJ/(kg·K)]
Superficial thermal capacity of the layer times the unit variation of the room temperature	**CTs**	[kJ/m²]

STRATIGRAPHY – COVER PANEL																
Description of materials	**D**	**s**	**λ**	**m**	**λ_m**	**r**	**dT (*)**	**Tf**	**Ps**	**μ**	**Rv**	**dP**	**DS**	**Pv**	**CT**	**CTS**
Room air								20	2							
Internal surface layer						0,100	0,2	19,8	2							
Fermacell	1150	1			0,32	0,031	0,1	19,4	2,24	13	0,7	0	11,50	1,51	1,1	12,35
X-Lam 8	480	8			0,13	0,615	1,3	18,1	2,06	60	25,6	0	38,40	1,51	1,6	56,76
Polyvap SA	1300	0,2			12500		0	18,1	2,06	690000	7.359,2	0,64	2,60	0,87	1,7	4,08
Agrop Swp 14 mm	490	1,4			0,13	0,108	0,2	17,9	2,04	60	4,5	0	6,86	0,87	1,6	10,04
Stiferite GT 100	36	10			0,023	4,348	9,2	8,7	1,12	150	80,0	0,01	3,60	0,86	1,453	2,85
Agrop Swp 14 mm	490	1,4			0,13	0,108	0,2	8,5	1,1	60	4,5	0	6,86	0,86	1,6	5,88
Agrop Swp 14 mm	490	1,4			0,13	0,108	0,2	8,3	1,09	60	4,5	0	6,86	0,86	1,6	5,78
Sarnafil G 410-15 EL Sika	1380	0,1			0,16	0,025	0,1	8,2	1,08	15000	80,0	0,01	1,38	0,86	0,9	0,65
Gravel	1700	5			0,2	0,250	0,5	7,7	1,04	5	1,3	0	85,00	0,85	0,84	35,94
External surface layer						0,040	0,1	7,6	1							
TOTALI:		**28,5**				**5,733**							**163,06**			**134,34**

Theoretic transmittance:	[W/(m²·K)]	0,174
Security increase (0[%]):	[W/(m²·K)]	0,174
Rounded number:		
Adopted transmittance:	[W/(m²·K)]	**0,174**

(*) The temperature differences in the various layers are obtained with a superficial internal thermal resistance of 0.25 [(m²·K)/W] as foreseen in table 2 in UNI EN ISO 13788.

COMPARISON WITH THE LIMIT VALUES		
Type of opaque structure	**:Horizontal/inclination**	
Correct upper thermal transmission Uc	**:0,174**	[W/(m²·K)]
Limit value of the transmittance	**:0,320**	[W/(m²·K)]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3) Thermal transmission of the partition elements between the residential units.

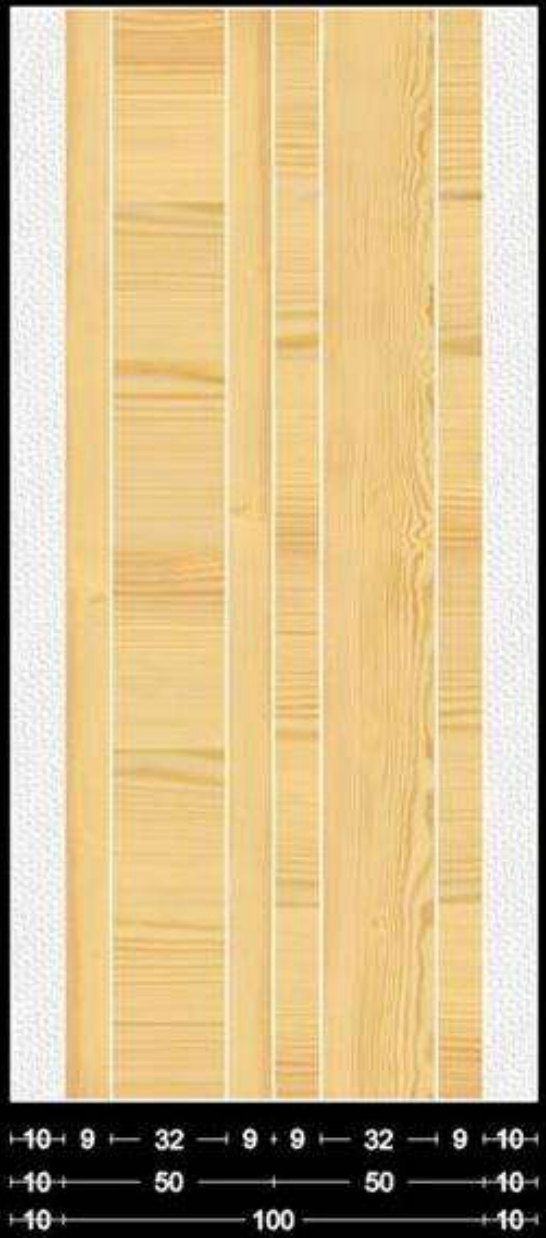
DEFINTION	SYMBOL	UNIT
Volumetric mass of the layer. Density.	**D**	[kg/m³]
Thickness	**s**	[cm]
Indicative conductivity reference	**λ**	[W/(m·K)]
Conductivity calculation	**λ_m**	[W/(m·K)]
Increase percentile	**m**	[%]
Internal unit thermal resistance (opposite to the conductance)	**r**	[(m²·K)/W]
Temperature difference between the surfaces that delimit the layer	**dT**	[°C]
Surface temperature on the bottom of the layer	**Tf**	[°C]
Saturation pressure of the water vapour	**Ps**	[kPa]
Resistance of the vapour passage	**μ**	-
Resistance of the flux of vapour of the layer	**Rv**	[m²sPa/kg]
Pressure difference between the surfaces that delimit the layer	**dP**	[kPa]
Partial pressure of the water vapour	**Pv**	[kPa]
Superficial mass of the layer	**Ds**	[kg/m²]
Mass and thermal capacity of the layer's material	**CT**	[kJ/(kg·K)]
Superficial thermal capacity of the layer times the unit variation of the room temperature	**CTs**	[kJ/m²]

STRATIGRAPHY – INTERNAL WALL																
Description of materials	**D**	**s**	**λ**	**m**	**λ_m**	**r**	**dT (*)**	**Tf**	**Ps**	**μ**	**Rv**	**dP**	**DS**	**Pv**	**CT**	**CTS**
Room air								20	2							
Internal surface layer						0,130	1,5	18,5	2							
Fermacell	1150	1			0,32	0,031	0,3	16,9	1,91	13	0,7	0,01	11,50	1,50	1,1	11,06
X-Lam 100	480	10			0,13	0,769	8,5	8,4	1,1	60	32,0	0,63	48,00	0,87	1,6	40,84
Fermacell	1150	1			0,32	0,031	0,3	8	1,04	13	0,7	0,01	11,50	0,85	1,1	6,55
Internal surface layer						0,130	1,5	7,6	1							
TOTALI:		**12**				**1,091**							**71**			**58,45**

Theoretic transmittance:	[W/(m²·K)]	0,916
Security increase (0[%]):	[W/(m²·K)]	0,916
Rounded number:		
Adopted transmittance:	[W/(m²·K)]	**0,916**

(*) The temperature differences in the various layers are obtained with a superficial internal thermal resistance of 0.25 [(m²·K)/W] as foreseen in table 2 in UNI EN ISO 13788.

COMPARISON WITH THE LIMIT VALUES		
Type of opaque structure	**:Vertical**	
Correct upper thermal transmission Uc	**:0,916**	[W/(m²·K)]
Limit value of the transmittance	**:0,800**	[W/(m²·K)]

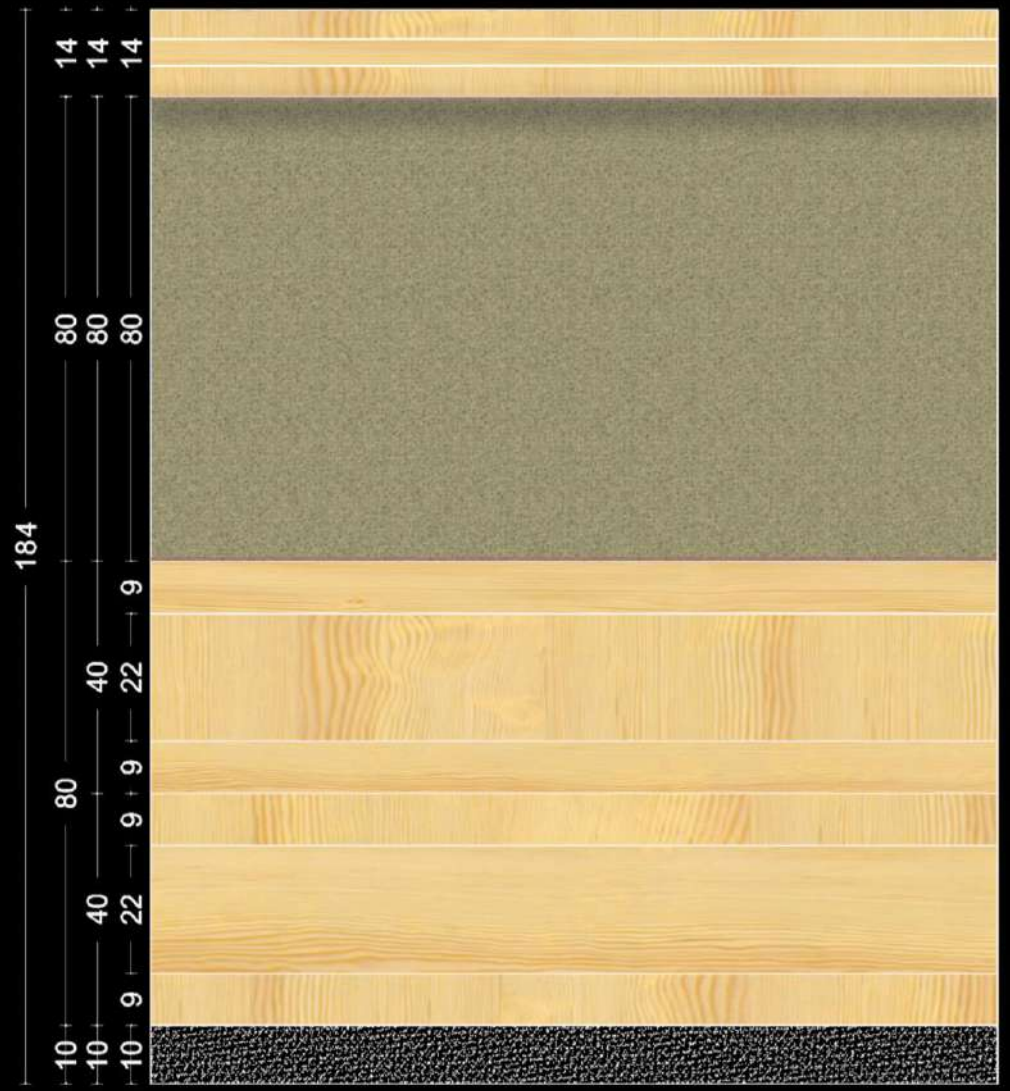

10 9 32 9 9 32 9 10
10 50 50 10
10 100 10

STRATIGRAPHY – ATTIC PANEL																
Description of materials	**D**	**s**	**λ**	**m**	**λ_m**	**r**	**dT (*)**	**Tf**	**Ps**	**μ**	**Rv**	**dP**	**DS**	**Pv**	**CT**	**CTS**
Room air								20	2							
Internal surface layer						0,170	0,5	19,5	2							
Parquet	850	2			0,22	0,091	0,2	19,1	2,2	43	4,6	0,03	17,00	1,48	2,4	39,30
Agrop Swp 14 mm	490	1,4			0,13	0,108	0,3	18,8	2,16	60	4,5	0,03	6,86	1,45	1,6	10,44
Stiferite GT 80	36	8			0,023	3,484	9,4	9,4	1,17	150	64,0	0,42	2,88	1,03	1,453	2,40
X-Lam 8	480	8			0,13	0,615	1,7	7,8	1,05	60	25,6	0,17	38,40	0,86	1,6	31,19
Fermacell	1150	1			0,32	0,031	0,1	7,7	1,04	13	0,7	0	11,50	0,85	1,1	6,38
External surface layer						0,040	0,1	7,6	1							
TOTALI:		**20,4**				**4,539**							**76,64**			**89,72**

Theoretic transmittance:	[W/(m²·K)]	0,220
Security increase (0[%]):	[W/(m²·K)]	0,220
Rounded number:		
Adopted transmittance:	[W/(m²·K)]	**0,220**

(*) The temperature differences in the various layers are obtained with a superficial internal thermal resistance of 0.25 [(m²·K)/W] as foreseen in table 2 in UNI EN ISO 13788.

COMPARISON OF LIMIT VALUE		
Type of opaque structure	**:Horizontal/inclination**	
Correct upper thermal transmission Uc	**:0,220**	[W/(m²·K)]
Limit value of the transmittance	**:0,360**	[W/(m²·K)]


184
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4) Thermal characteristics of the window components of the building.

Key:	
DEFINITION	**SYMBOL**
Glass surface	**Ag**
Surface of the frame	**Af**
Length of the glass surface	**Lg**
Thermal transmittance of the glass	**Ug**
Thermal transmittance of the frame	**Uf**
Linear thermal transmittance (nil in the case of single pane)	**Ul**
Thermal transmittance of total window fixture	**Uw**
Inverse of the conductance surface units	**(*)**
Inverse of the total thermal resistance	**(**)**

W103 - FM							
TRANSMITTANCE				**THERMAL RESISTANCE**			
Tot. (**) [W/(m²·K)]:	1,10			Tot. [(m²·K)/W]:	0,91		
TYPE	**Ag**	**Af**	**Lg**	**Ug**	**Uf**	**Ul**	**Uw**
	[m²]	[m²]	[m]	[W/m²°C]	[W/m²°C]	[W/m°C]	[W/m²°C]
SINGLE FIXTURE	1,00	0,67	4,16	0,70	1,50	0,03	1,10

Thermal transmittance of the transparent component	
Transmittance of the transparent closure, inclusive of the casing [W/(m²·K)]	**1,099**
Central transmittance of the glass [W/(m²·K)]	**0,700**

W107 - PS INT							
TRANSMITTANCE				**THERMAL RESISTANCE**			
Tot. (**) [W/(m²·K)]:	1,05			Tot. [(m²·K)/W]:	0,96		
TYPE	**Ag**	**Af**	**Lg**	**Ug**	**Uf**	**Ul**	**Uw**
	[m²]	[m²]	[m]	[W/m²°C]	[W/m²°C]	[W/m°C]	[W/m²°C]
SINGLE FIXTURE	1,40	0,61	5,12	0,70	1,50	0,04	1,05

Thermal transmittance of the transparent component	
Transmittance of the transparent closure, inclusive of the casing [W/(m²·K)]	**1,047**
Central transmittance of the glass [W/(m²·K)]	**0,700**

W102 - FK							
TRANSMITTANCE				**THERMAL RESISTANCE**			
Tot. (**) [W/(m²·K)]:	1,13			Tot. [(m²·K)/W]:	0,89		
TYPE	**Ag**	**Af**	**Lg**	**Ug**	**Uf**	**Ul**	**Uw**
	[m²]	[m²]	[m]	[W/m²°C]	[W/m²°C]	[W/m°C]	[W/m²°C]
SINGLE FIXTURE	0,81	0,64	3,70	0,70	1,50	0,03	1,13

Thermal transmittance of the transparent component	
Transmittance of the transparent closure, inclusive of the casing [W/(m²·K)]	**1,128**
Central transmittance of the glass [W/(m²·K)]	**0,700**

W101 - FB							
TRANSMITTANCE				**THERMAL RESISTANCE**			
Tot. (**) [W/(m²·K)]:	1,05			Tot. [(m²·K)/W]:	0,96		
TYPE	**Ag**	**Af**	**Lg**	**Ug**	**Uf**	**Ul**	**Uw**
	[m²]	[m²]	[m]	[W/m²°C]	[W/m²°C]	[W/m°C]	[W/m²°C]
SINGLE FIXTURE	1,51	0,81	5,22	0,70	1,50	0,03	1,05

Thermal transmittance of the transparent component	
Transmittance of the transparent closure, inclusive of the casing [W/(m²·K)]	**1,047**
Central transmittance of the glass [W/(m²·K)]	**0,700**

W106 - PS EST							
TRANSMITTANCE				**THERMAL RESISTANCE**			
Tot. (**) [W/(m²·K)]:	0,99			Tot. [(m²·K)/W]:	1,01		
TYPE	**Ag**	**Af**	**Lg**	**Ug**	**Uf**	**Ul**	**Uw**
	[m²]	[m²]	[m]	[W/m²°C]	[W/m²°C]	[W/m°C]	[W/m²°C]
SINGLE FIXTURE	6,06	2,11	14,12	0,70	1,50	0,05	0,99

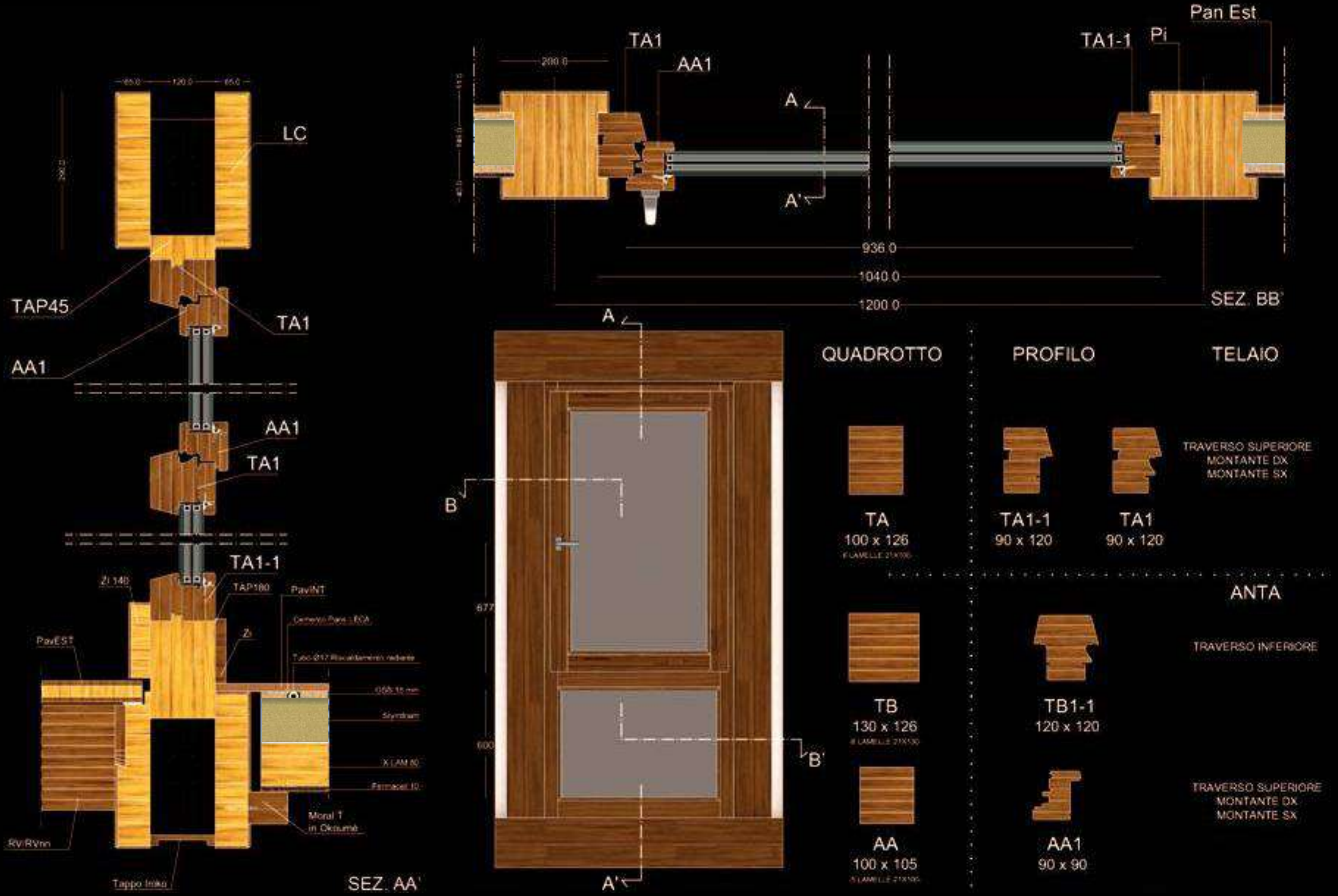
Thermal transmittance of the transparent component	
Transmittance of the transparent closure, inclusive of the casing [W/(m²·K)]	**0,993**
Central transmittance of the glass [W/(m²·K)]	**0,700**

W104 - FS							
TRANSMITTANCE				**THERMAL RESISTANCE**			
Tot. (**) [W/(m²·K)]:	0,92			Tot. [(m²·K)/W]:	1,08		
TYPE	**Ag**	**Af**	**Lg**	**Ug**	**Uf**	**Ul**	**Uw**
	[m²]	[m²]	[m]	[W/m²°C]	[W/m²°C]	[W/m°C]	[W/m²°C]
SINGLE FIXTURE	2,22	0,53	6,38	0,70	1,50	0,03	0,92

Thermal transmittance of the transparent component	
Transmittance of the transparent closure, inclusive of the casing [W/(m²·K)]	**0,925**
Central transmittance of the glass [W/(m²·K)]	**0,700**

W105 - FZ							
TRANSMITTANCE				**THERMAL RESISTANCE**			
Tot. (**) [W/(m²·K)]:	1,07			Tot. [(m²·K)/W]:	0,94		
TYPE	**Ag**	**Af**	**Lg**	**Ug**	**Uf**	**Ul**	**Uw**
	[m²]	[m²]	[m]	[W/m²°C]	[W/m²°C]	[W/m°C]	[W/m²°C]
SINGLE FIXTURE	1,71	0,94	7,38	0,70	1,50	0,03	1,07

Thermal transmittance of the transparent component	
Transmittance of the transparent closure, inclusive of the casing [W/(m²·K)]	**1,068**
Central transmittance of the glass [W/(m²·K)]	**0,700**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TAP45
TA1
AA1
AA1
TA1
TA1-1
PavINT
PavEST
RV/RVnn
Moral 1
in Okoumè
Tappo Iroko
SEZ. AA'
TA1
AA1
TA1-1
Pi
Pan Est
A
A'
936.0
1040.0
1200.0
SEZ. BB'
A
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B'
A'
QUADROTTO
PROFILO
TELAIO
TA
100 x 126
TA1-1
90 x 120
TA1
90 x 120
TRAVERSO SUPERIORE
MONTANTE DX
MONTANTE SX
ANTA
TRAVERSO INFERIORE
TB
130 x 126
TB1-1
120 x 120
TRAVERSO SUPERIORE
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AA
100 x 105
AA1
90 x 90

5) Calculation of the surface temperature and of the interstitial condensation of the building structure according to the norm UNI EN ISO 13788

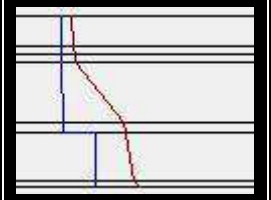
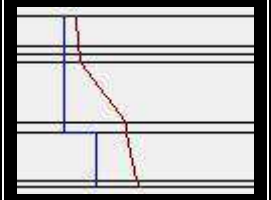
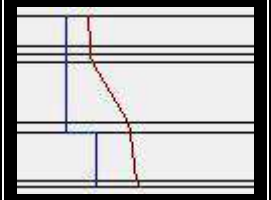
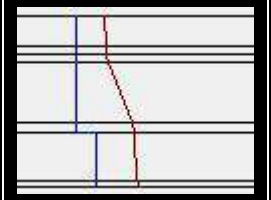
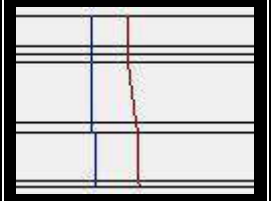
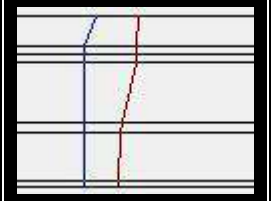
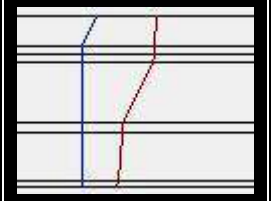
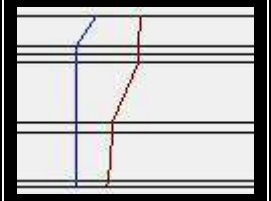
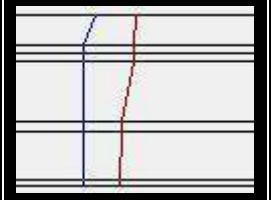
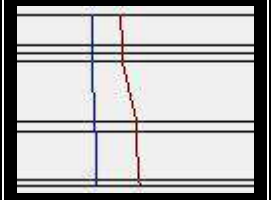
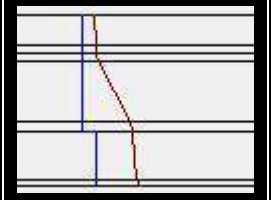
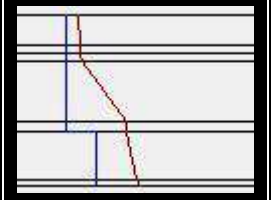
DEFINITION	SYMBOL	UNIT
Vapour mass per accumulated unit surface in correspondence of an interface	*M*a	[kg/m²]
Specific thermal resistance	*R*	[(m²·K)/W]
Temperature	*T*	[°C]
Hygroscopic resistance factor	*Mu*	
Temperature factor in correspondence on the internal surface	*f* Rsi	
Project thermal factor in correspondence of the internal surface	*f*Rsi, min	
Thickness of the current layer	*S*	[cm]

COVER PANEL			
Material	**Mu**	**R**	**S**
		[(m²·K)/W]	[cm]
Fermacell	13	0,031	1
X-Lam 8	60	0,615	8
Polyvap SA	690000	0	0,2
Agrop Swp 14 mm	60	0,108	1,4
Stiferite GT 100	150	4,348	10
Agrop Swp 14 mm	60	0,108	1,4
Agrop Swp 14 mm	60	0,108	1,4
Sarnafil G 410-15 EL Sika	15000	0,006	0,1
Gravel	5	0,25	5
Quality factor = 0,9580		**Tot. 5,733**	**Total: 28,5**

(*) The total thermal resistance includes the thermal resistances of the internal and external surface layers defined in the archive.
The Hygrometric evaluation is carried-out with the thermal resistances of the surface layers foreseen by Table 2 of UNI EN ISO 13788.

Calculation results										
Month	**Te**	**URe**	**Ti**	**Uri**	**Pe**	**Pi**	**Tmin**	**FRsi**	**Gc**	**Ma**
	[°C]	[%]	[°C]	[%]	[kPa]	[kPa]	[°C]		[kg/m²]	[kg/m²]
January	7,6	82	20	65	0,85	1,51	16,6	0,7250	0	0
February	8,7	78	20	65	0,87	1,51	16,6	0,6990	0	0
March	11,4	67	20	65	0,9	1,51	16,6	0,6040	0	0
April	14,7	66	20	65	1,1	1,51	16,6	0,3570	0	0
May	18,5	67	20	65	1,42	1,51	16,6		0	0
June	22,9	66	20	65	1,83	1,51	16,6		0	0
July	25,7	57	20	65	1,86	1,51	16,6		0	0
August	25,3	64	20	65	2,06	1,51	16,6		0	0
September	22,4	67	20	65	1,81	1,51	16,6		0	0
October	17,4	73	20	65	1,44	1,51	16,6		0	0
November	12,6	84	20	65	1,21	1,51	16,6	0,5400	0	0
December	8,9	82	20	65	0,92	1,51	16,6	0,6930	0	0

Verifications as per the norms
1) The quantity of condensation does not exceed 0.5 kg/m².
2) The quantity of condensation is limited to the quantity, which is re-evaporated.
3) The structure is not subject to surface condensation activities
THERMAL-HYGROMETRIC EVALUATION: ***V***

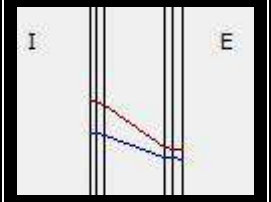
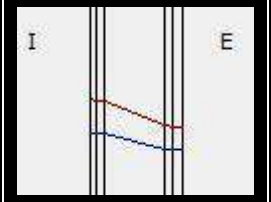
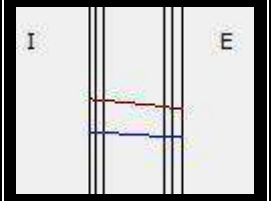
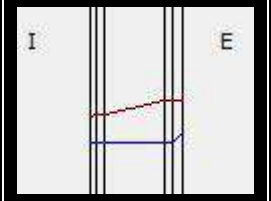
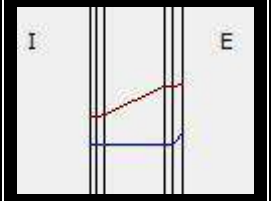
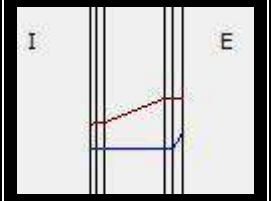
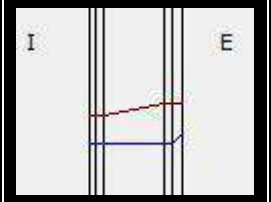
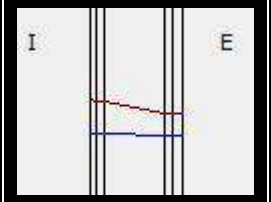
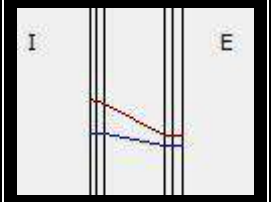
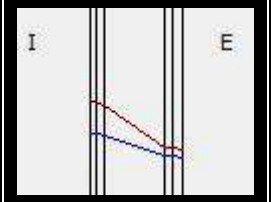
Graphic monthly summary			
January	February	March	April
			
May	June	July	August
			
September	October	November	December
			

EXTERNAL PANEL			
Materials	**Mu**	**R**	**S**
		[(m²·K)/W]	[cm]
Fermacell	13	0,031	1
Agrop Swp 14 mm	60	0,108	1,4
Stiferite GT 100	150	4,348	10
Agrop Swp 14 mm	60	0,108	1,4
Iroko slats	60	0,083	1,5
		Total: (*)	**Total:**
Quality factor = 0,9500		**4,848**	**15,3**

(*) The total thermal resistance includes the thermal resistances of the internal and external surface layers defined in the archive.
The Hygrometric evaluation is carried-out with the thermal resistances of the surface layers foreseen by Table 2 of UNI EN ISO 13788.

Calculation results										
Month	**Te**	**URe**	**Ti**	**Uri**	**Pe**	**Pi**	**Tmin**	**FRsi**	**Gc**	**Ma**
	[°C]	[%]	[°C]	[%]	[kPa]	[kPa]	[°C]		[kg/m²]	[kg/m²]
January	7,6	82	20	65	0,85	1,51	16,6	0,7250	0	0
February	8,7	78	20	65	0,87	1,51	16,6	0,6990	0	0
March	11,4	67	20	65	0,9	1,51	16,6	0,6040	0	0
April	14,7	66	20	65	1,1	1,51	16,6	0,3570	0	0
May	18,5	67	20	65	1,42	1,51	16,6		0	0
June	22,9	66	20	65	1,83	1,51	16,6		0	0
July	25,7	57	20	65	1,86	1,51	16,6		0	0
August	25,3	64	20	65	2,06	1,51	16,6		0	0
September	22,4	67	20	65	1,81	1,51	16,6		0	0
October	17,4	73	20	65	1,44	1,51	16,6		0	0
November	12,6	84	20	65	1,21	1,51	16,6	0,5400	0	0
December	8,9	82	20	65	0,92	1,51	16,6	0,6930	0	0

Verifications as per the norms
1) The quantity of condensation does not exceed 0.5 kg/m².
2) The quantity of condensation is limited to the quantity, which is re-evaporated.
3) The structure is not subject to surface condensation activities
THERMAL-HYGROMETRIC EVALUATION: ***V***

Graphic monthly summary			
January	February	March	April
			
May	June	July	August
			
September	October	November	December
			

All components of a *PAGANO structure* are verified according to the criteria established in the Italian 2005 Regulation:
D. Lgs. n° 192 which makes the Pagano build compliant to the legislative norms.

Eng. FOSSATI Erika