WACKER POLYMERS

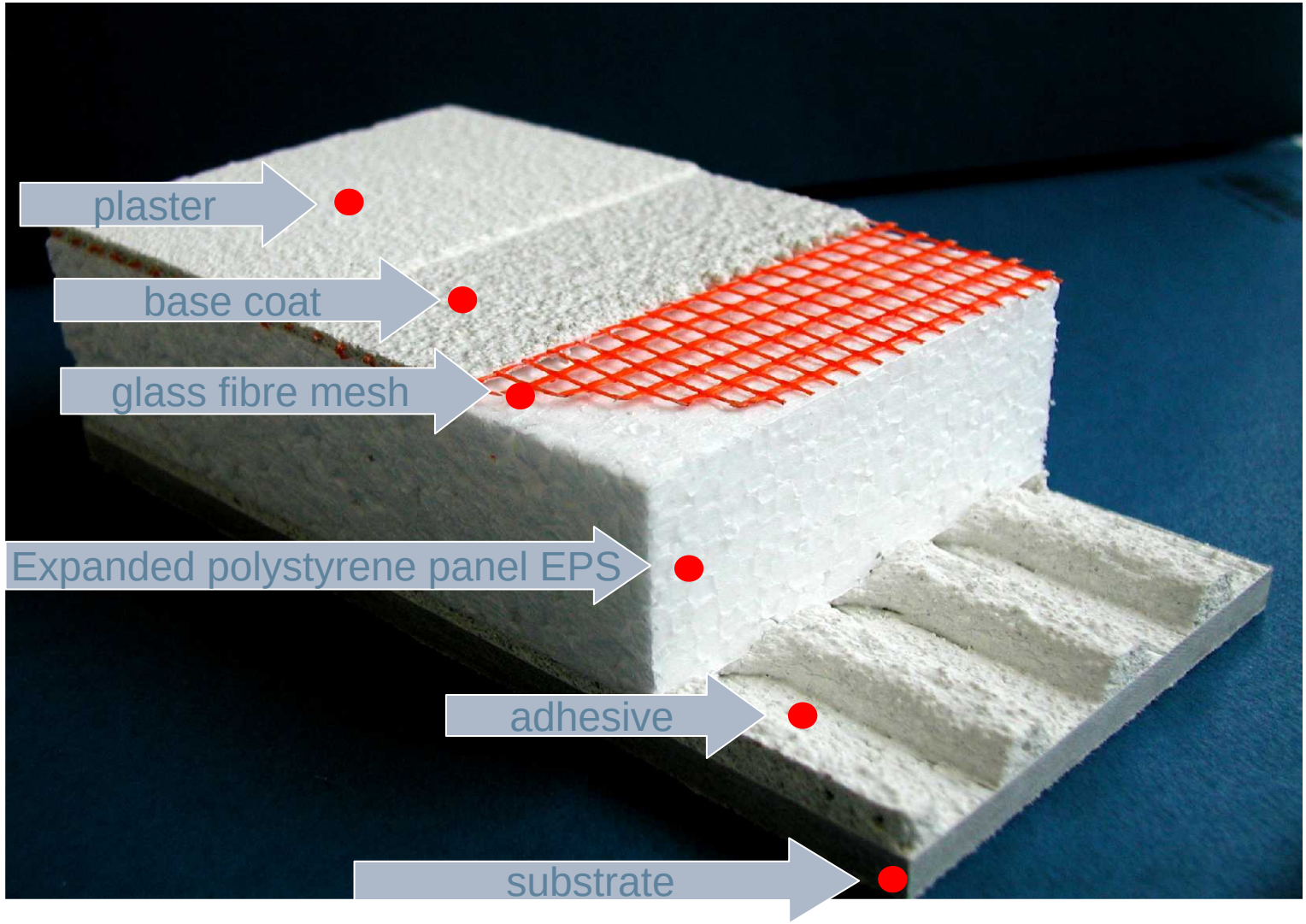
PERFORMANCE REQUIREMENTS AND STANDARDS FOR A SUCCESSFUL EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) / GREEN BUILDING CONFERENCE AT AUD

Mohammed Sanaobar, LBE TC Dubai, 25.06.08

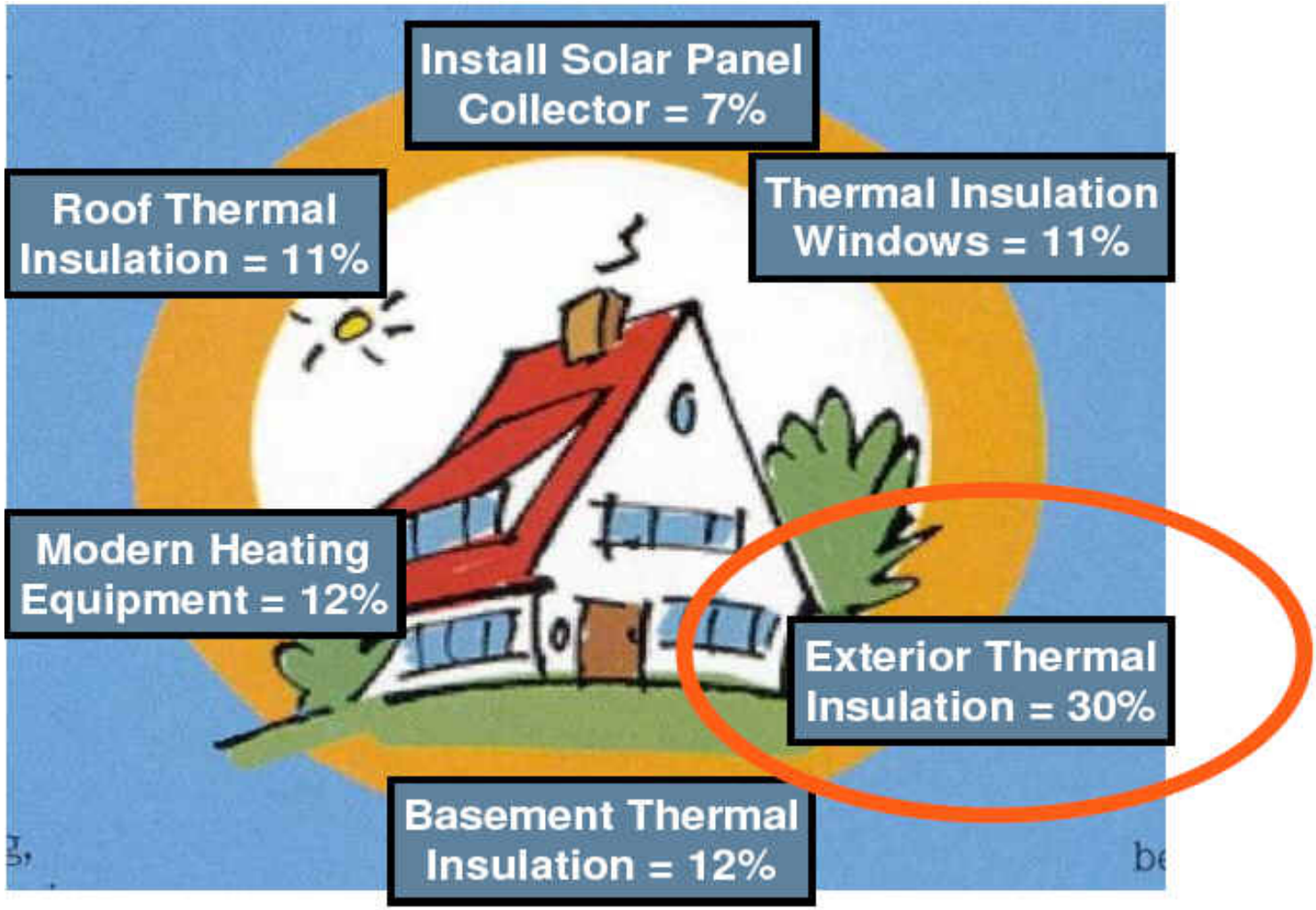
AGENDA

- THE EIFS / ETICS SYSTEM
- WHY EIFS / ETICS?
- MOST IMPORTANT COMPONENTS
- NORMS AND REGULATIONS
- CRITICAL FACTORS
- EOTA WALL
- CASE STUDY CHINA
- COST MODEL

THE EIFS / ETICS SYSTEM



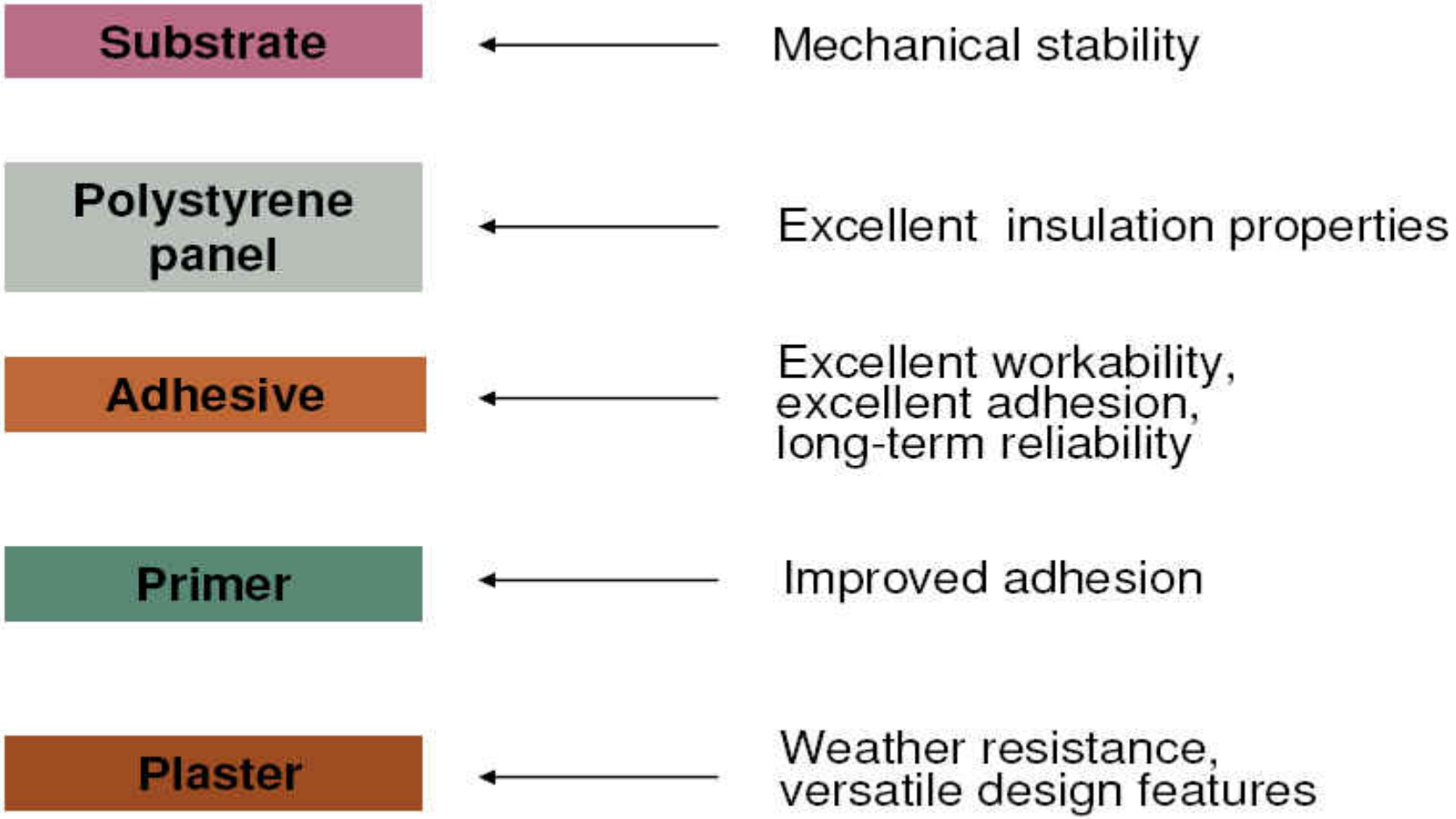
WHY EIFS / ETICS?
POSSIBILITIES FOR ENERGY SAVING: EIFS MAIN LEVER



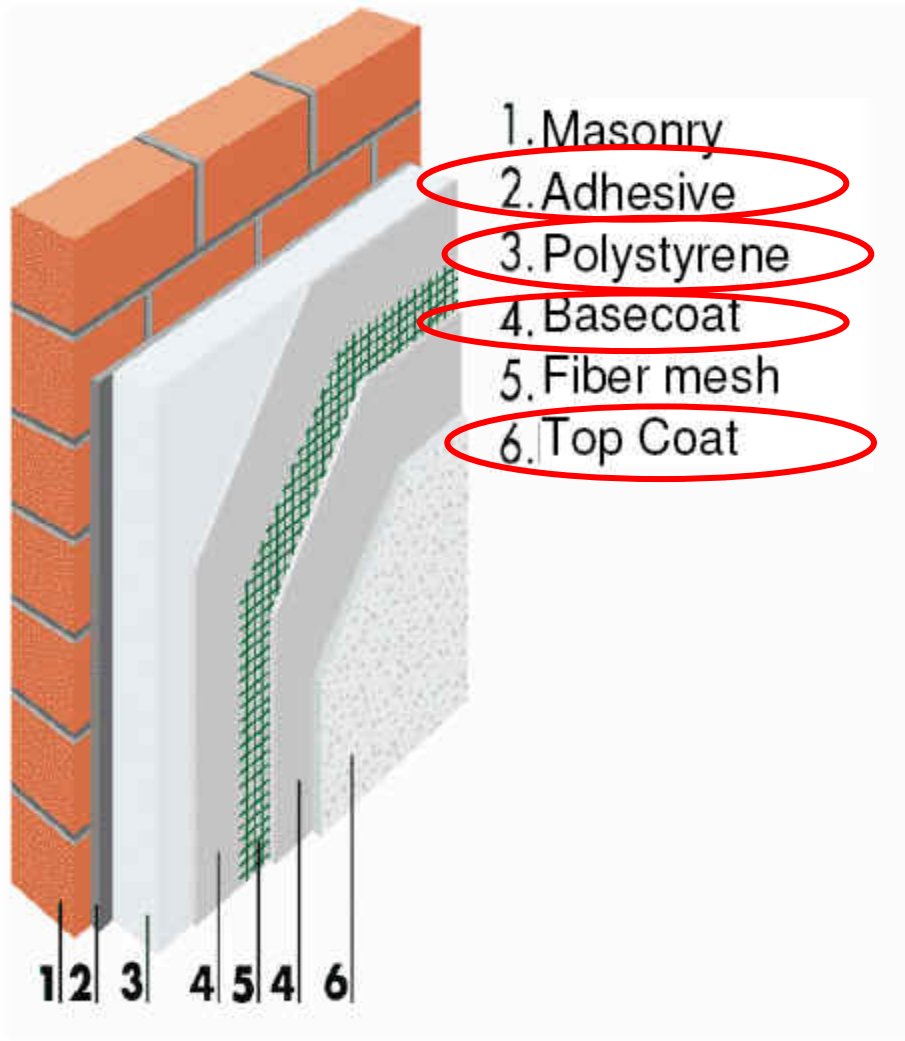
WHY EIFS?

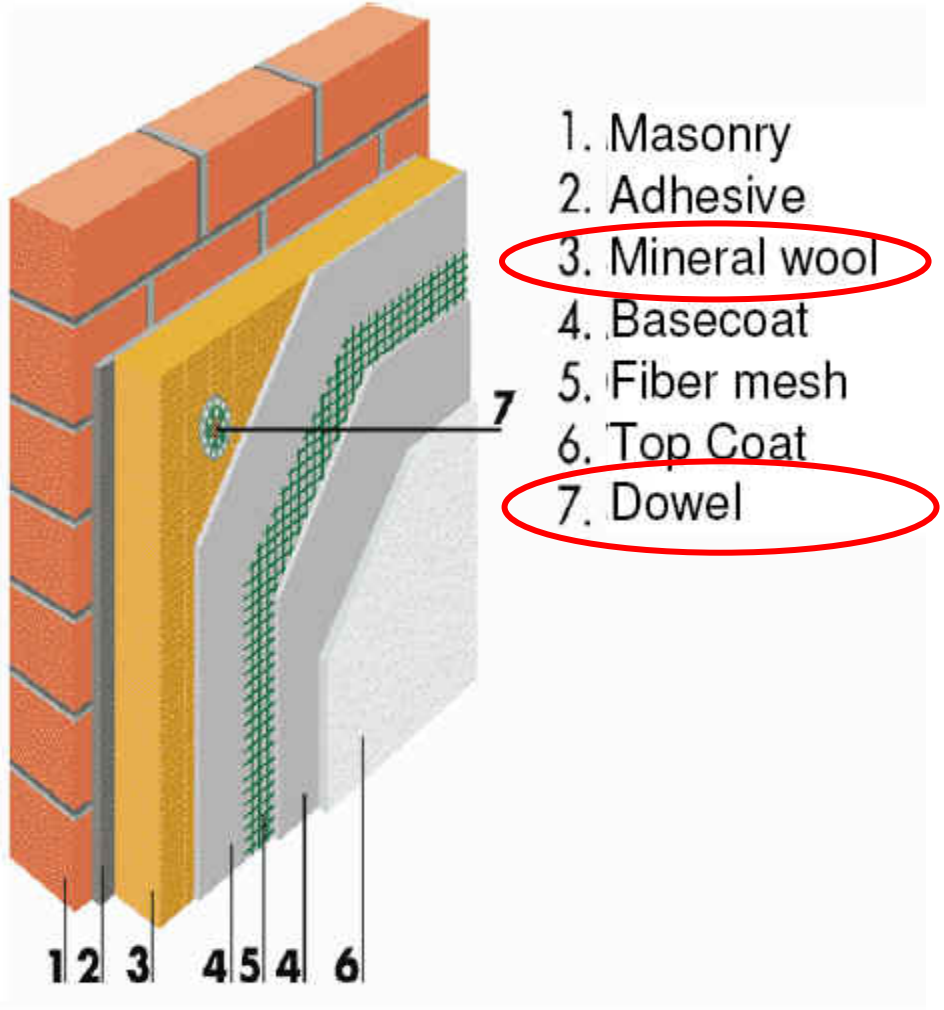
- EIFS has proved to have a superior energy efficiency by reducing heat transmission by approx 50%
- Improved energy efficiency helps to reduce harmful emissions typically associated with energy production such as CO2 emissions and other by-products
- Design Flexibility and Decorative Finishing
- Superior EIFS energy efficiency reduces required air conditioning equipment capacity and limits the physical effects of temperature fluctuations hence reducing structural stress
- EIFS can be applied to new and existing structures.
- EIFS is the ONLY solution for insulating existing buildings

MOST IMPORTANT COMPONENTS REQUIREMENTS

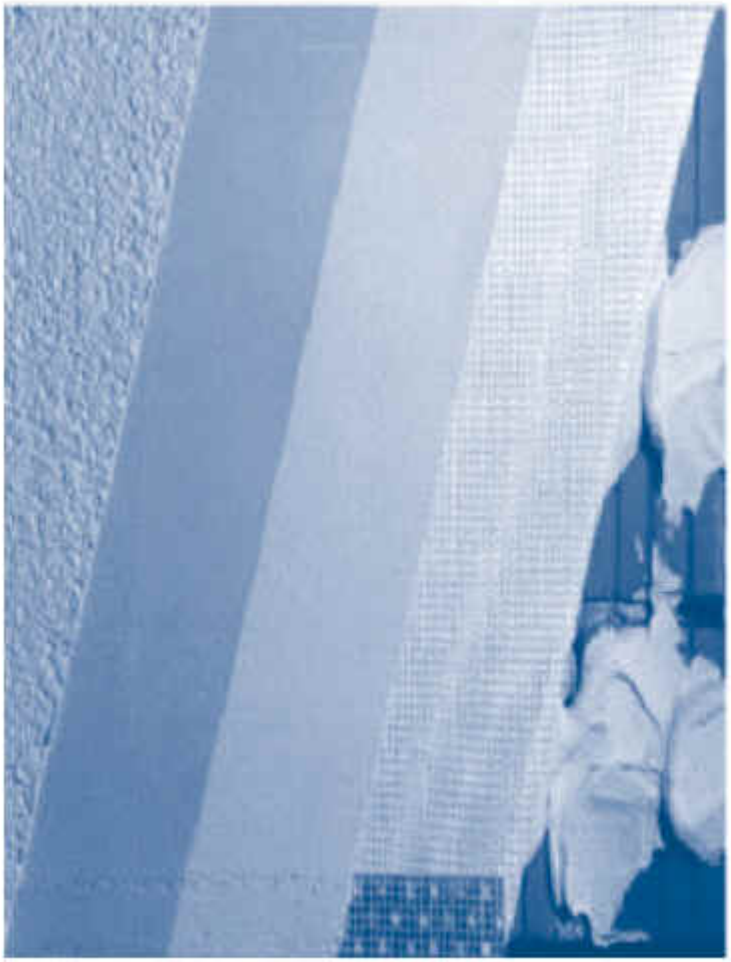


MOST IMPORTANT COMPONENTS





MOST IMPORTANT COMPONENTS
REQUIREMENTS ON THE FRESH AND HARDENED MORTAR



Requirements for fresh mortar:

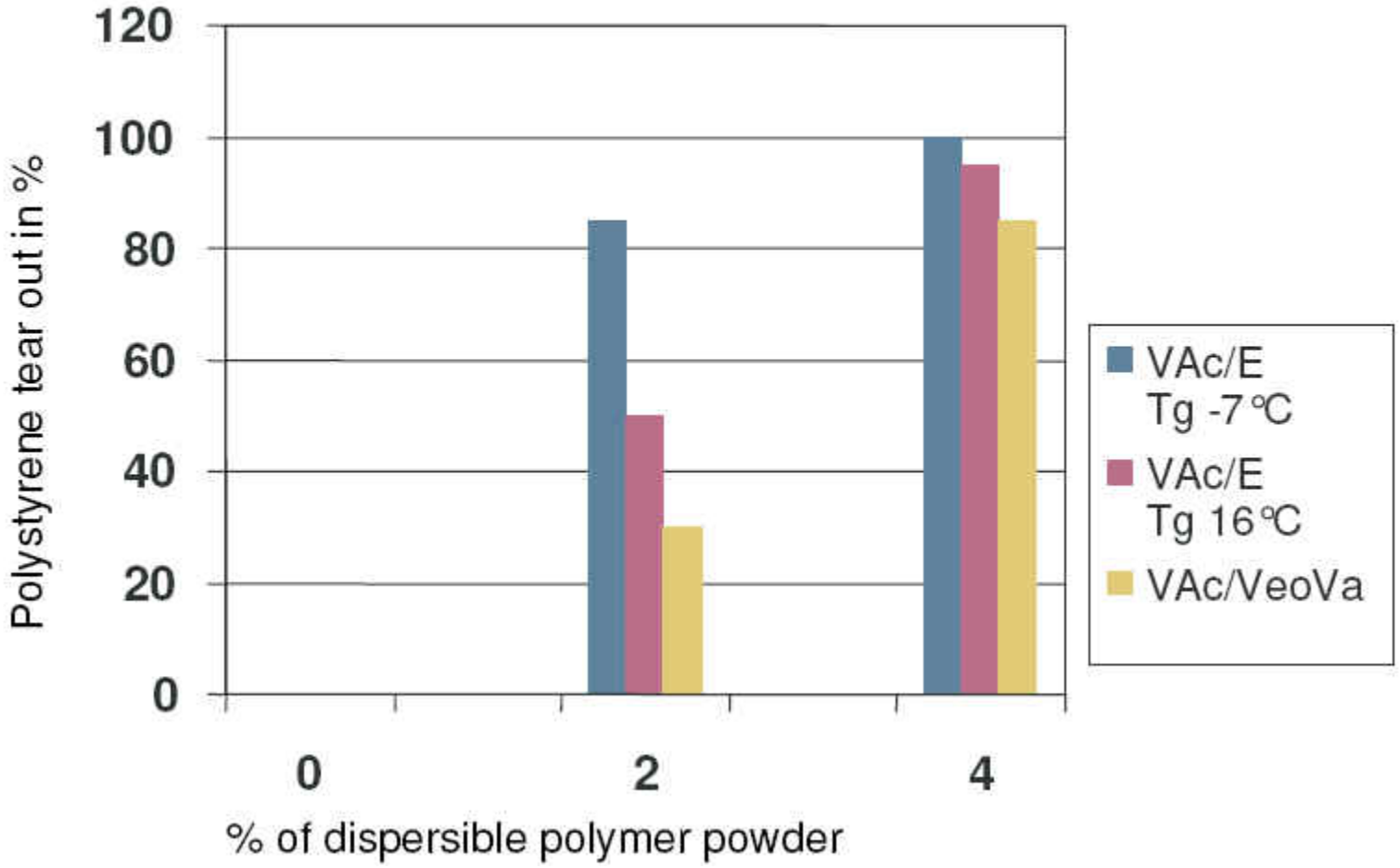
- Good workability for manual and machine application
- Long open time

Requirements for hardened mortar:

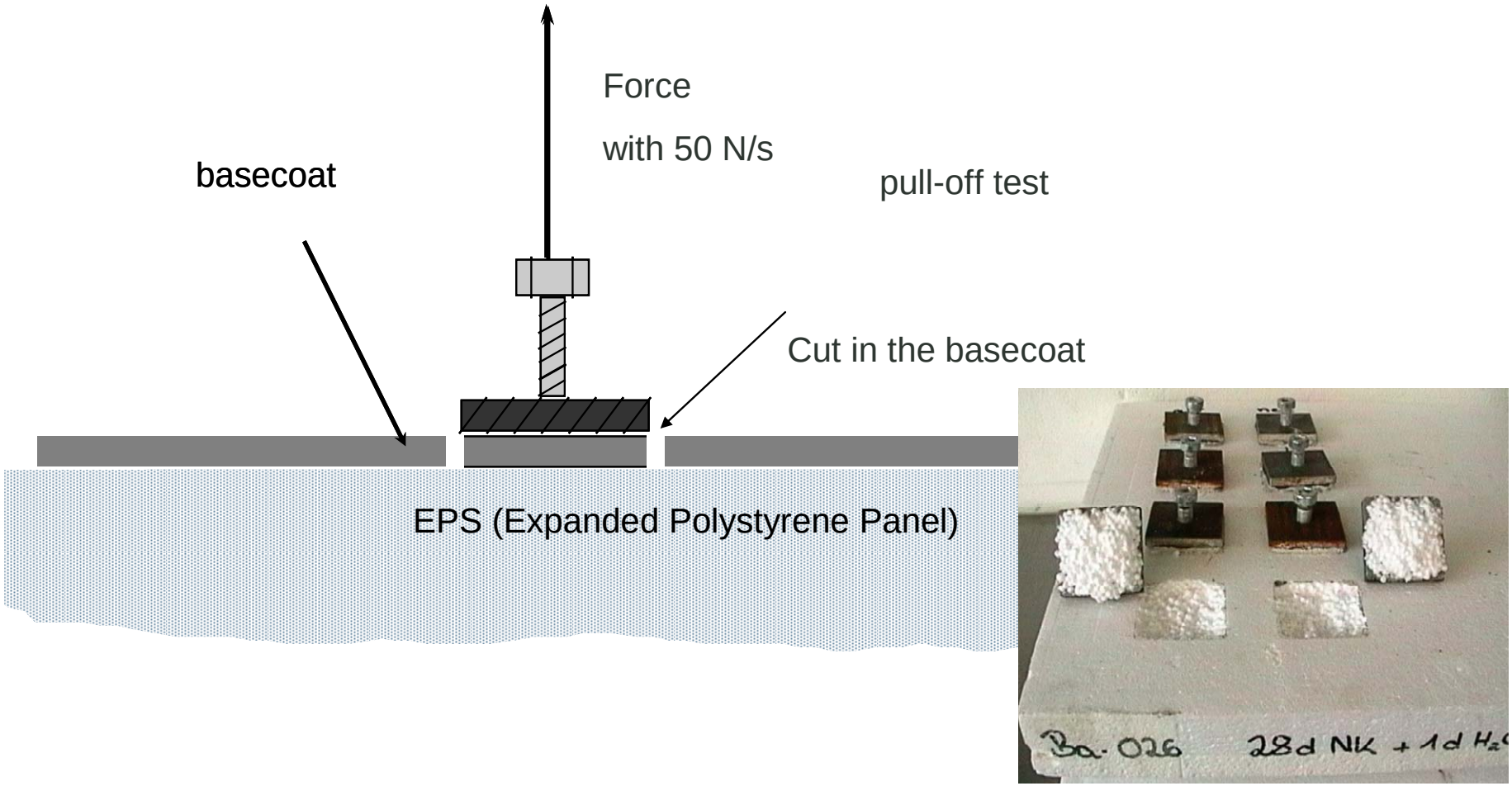
- Good adhesion to polystyrene boards and other substrates (concrete, bricks, old renders)
- High flexibility and impact strength
- Good vapor permeability
- Hydrophobic properties (water repellent)
- Good weathering resistance

MOST IMPORTANT COMPONENTS ADHESIVE AND BASECOAT MORTAR

Adhesion to polystyrene panels: storage 12 d sc + 2 d water immersion

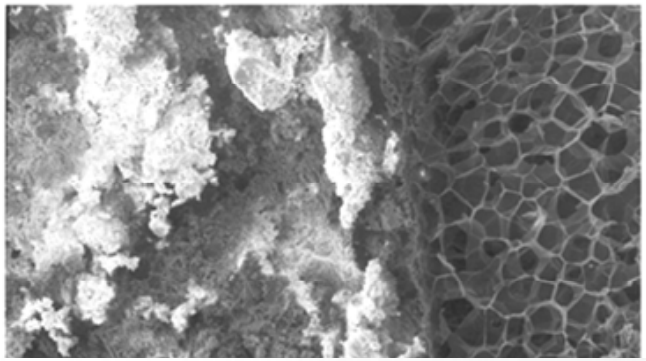


MOST IMPORTANT COMPONENTS
MEASUREMENT OF TENSILE ADHESION STRENGTH ON EPS



MOST IMPORTANT COMPONENTS
ADHESIVE AND BASECOAT MORTAR – SEM ANALYSIS

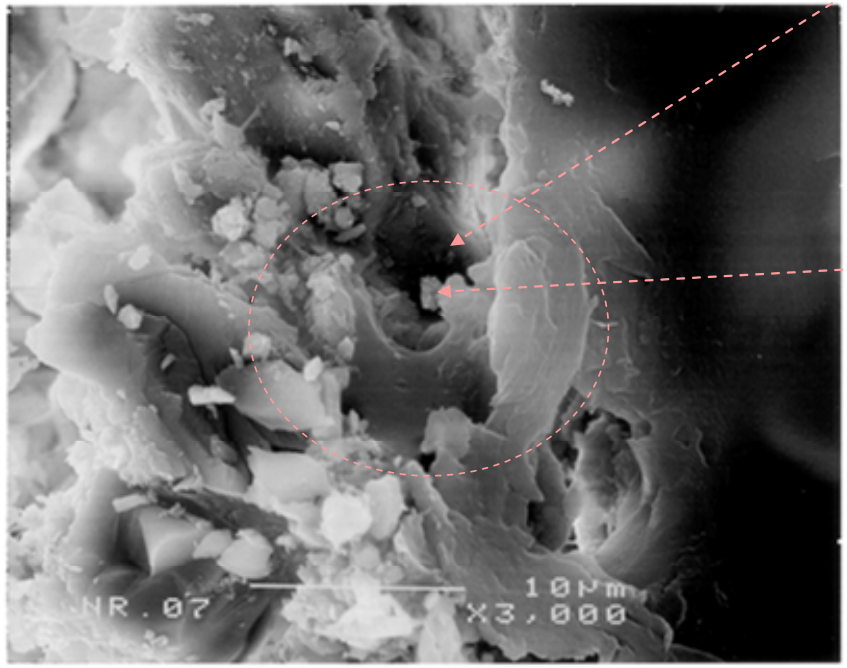
x 50 times

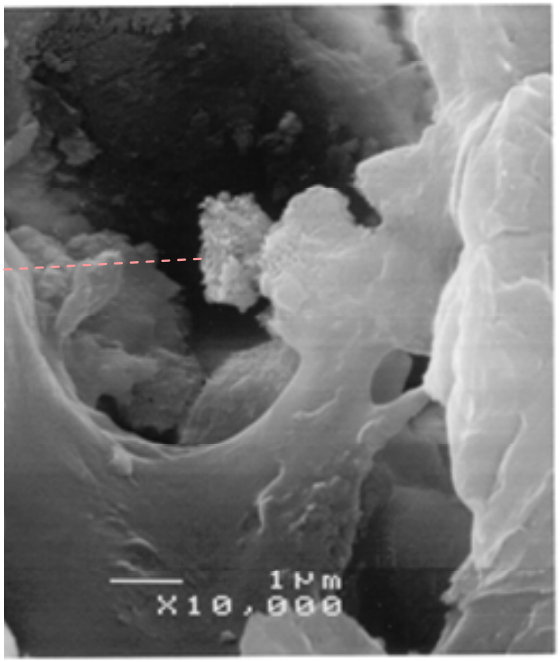


base coat EPS

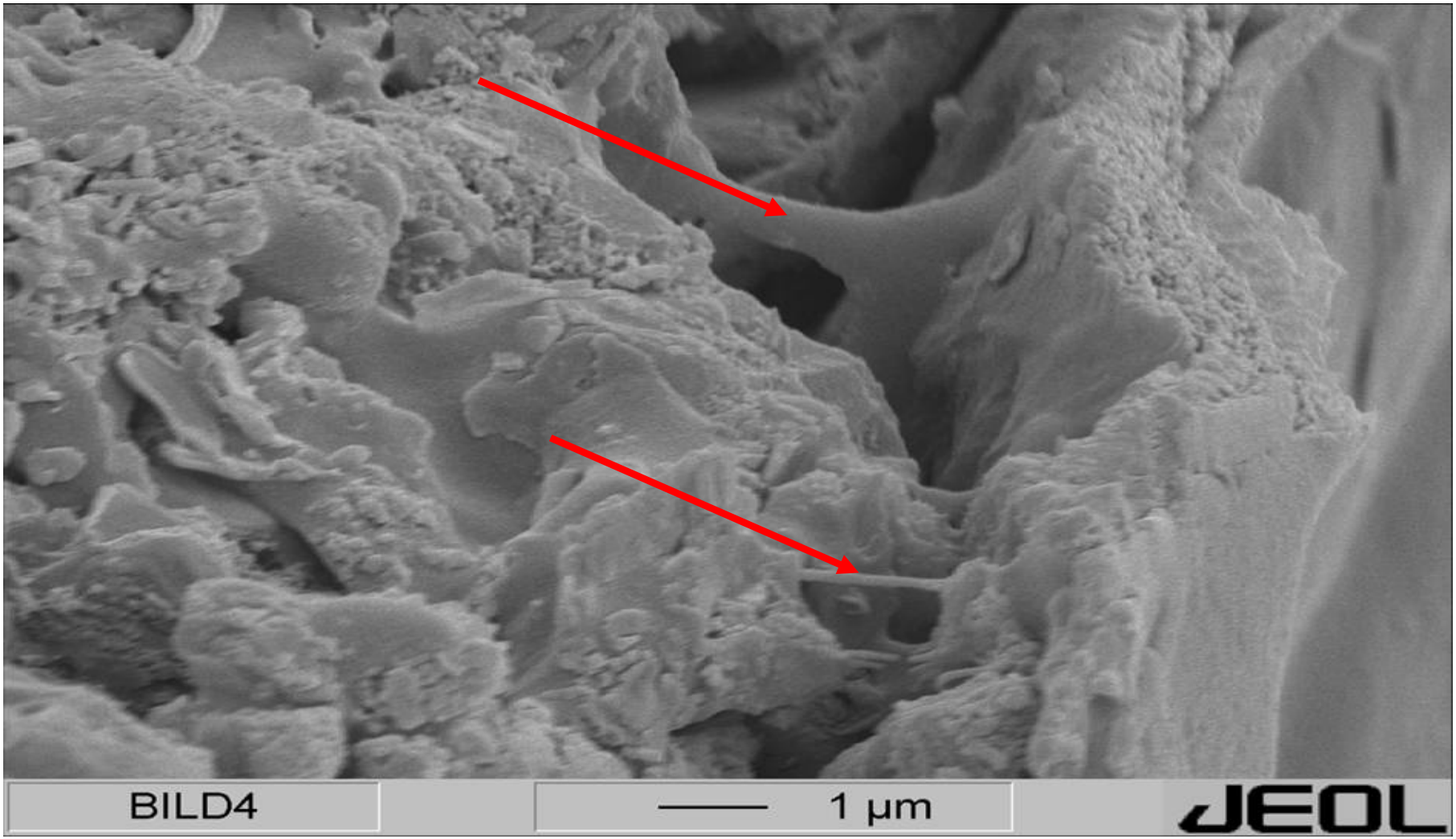
Polymer domain after film formation

x 3000 times

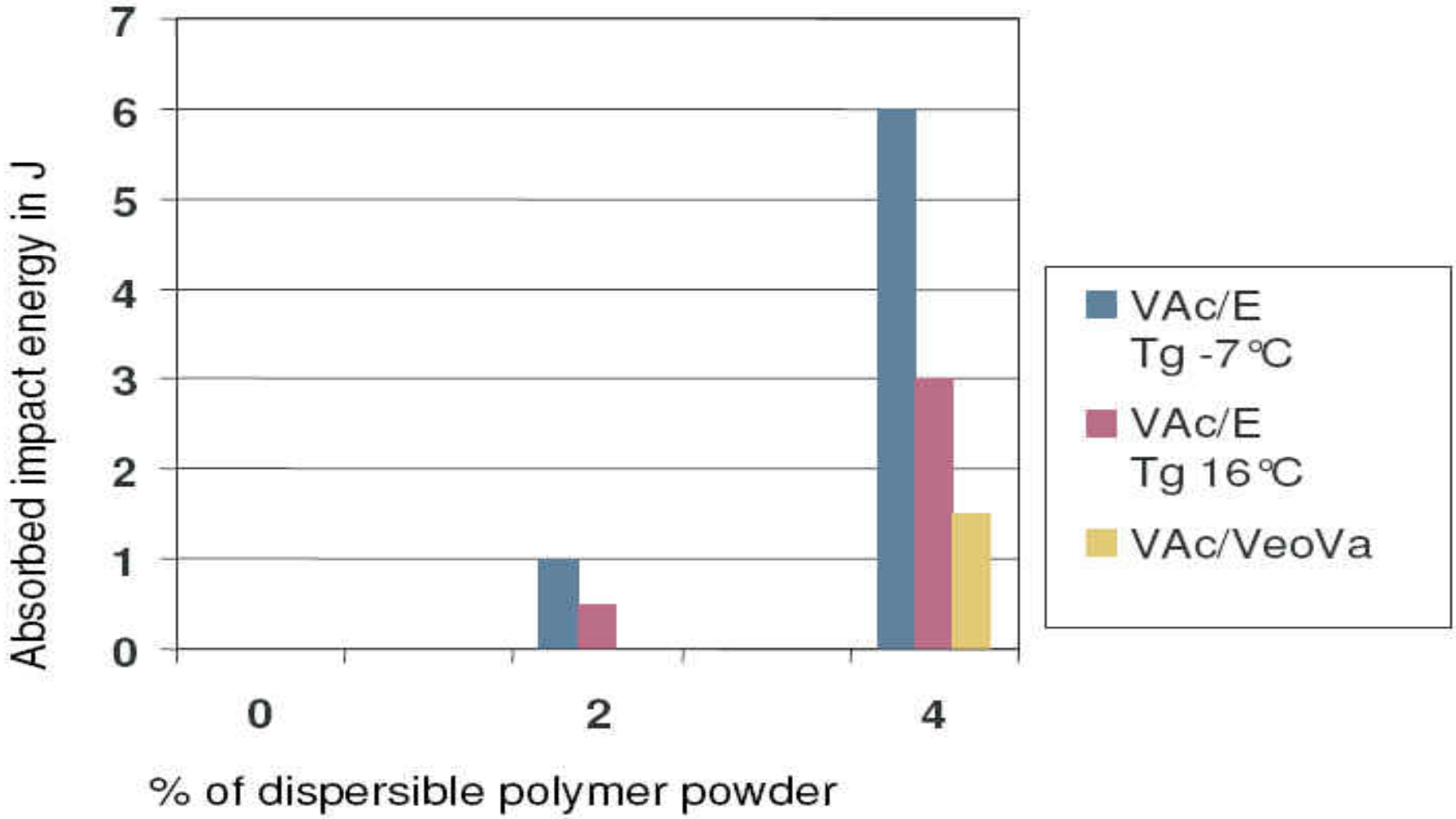




MOST IMPORTANT COMPONENTS
ADHESIVE AND BASECOAT MORTAR – SEM ANALYSIS



MOST IMPORTANT COMPONENT BASECOAT MORTAR IMPACT RESISTANCE



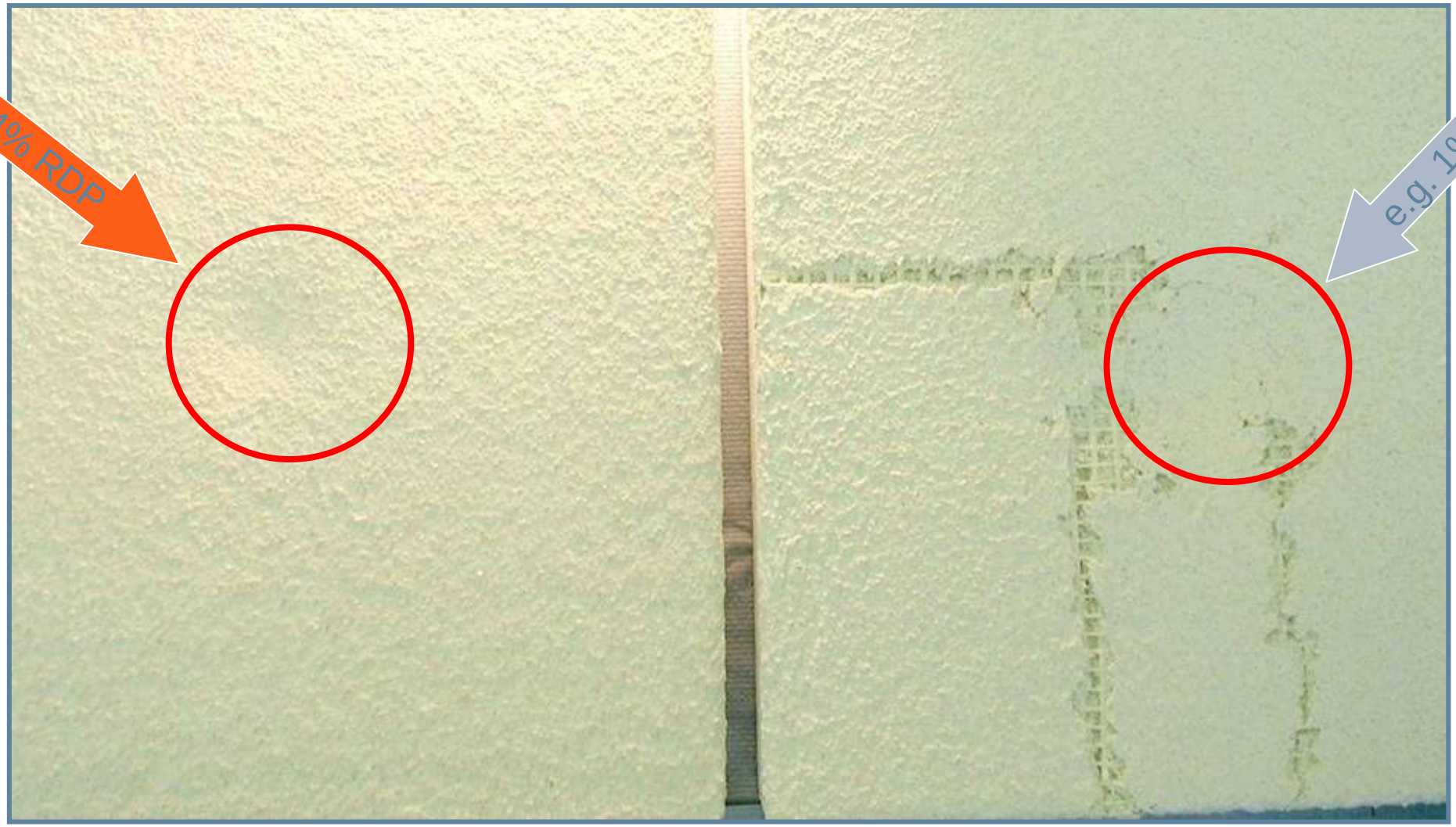
TEST AND CONVERSION
JOULE IN CM OR CM IN JOULE

Tube diameter	≥55mm	≥70mm
Steal Ball diameter	50mm	64 mm
Mass	500g Steal Ball	1000g Steal Ball
real wight **m** [kg]	**0,500**	**1,000**
g[m/s²]	9,80665	9,80665
	h=J/(m*g)	**h=J/(m*g)**
J	**h in cm**	**h in cm**
0,5	10,2	5,1
1,0	20,4	10,2
1,5	30,6	15,3
2,0	40,8	20,4
2,5	51,0	25,5
3,0	61,2	30,6
3,5	71,4	35,7
4,0	81,6	40,8
4,5	91,8	45,9
5,0	102,0	51,0
5,5	112,2	56,1
6,0	122,4	61,2
6,5	132,6	66,3
7,0	142,8	71,4
7,5	153,0	76,5
8,0	163,2	81,6
8,5	173,4	86,7
9,0	183,5	91,8
9,5	193,7	96,9
10,0	203,9	102,0
10,5	214,1	107,1
11,0	224,3	112,2
11,5	234,5	117,3
12,0	244,7	122,4
12,5	254,9	127,5

weight

Min. req..

MOST IMPORTANT COMPONENT BASECOAT MORTAR IMPACT TEST WITH 500 GRAM STEAL BALL



MOST IMPORTANT COMPONENTS
TOPCOAT

Topcoat:

Thin-layer plaster

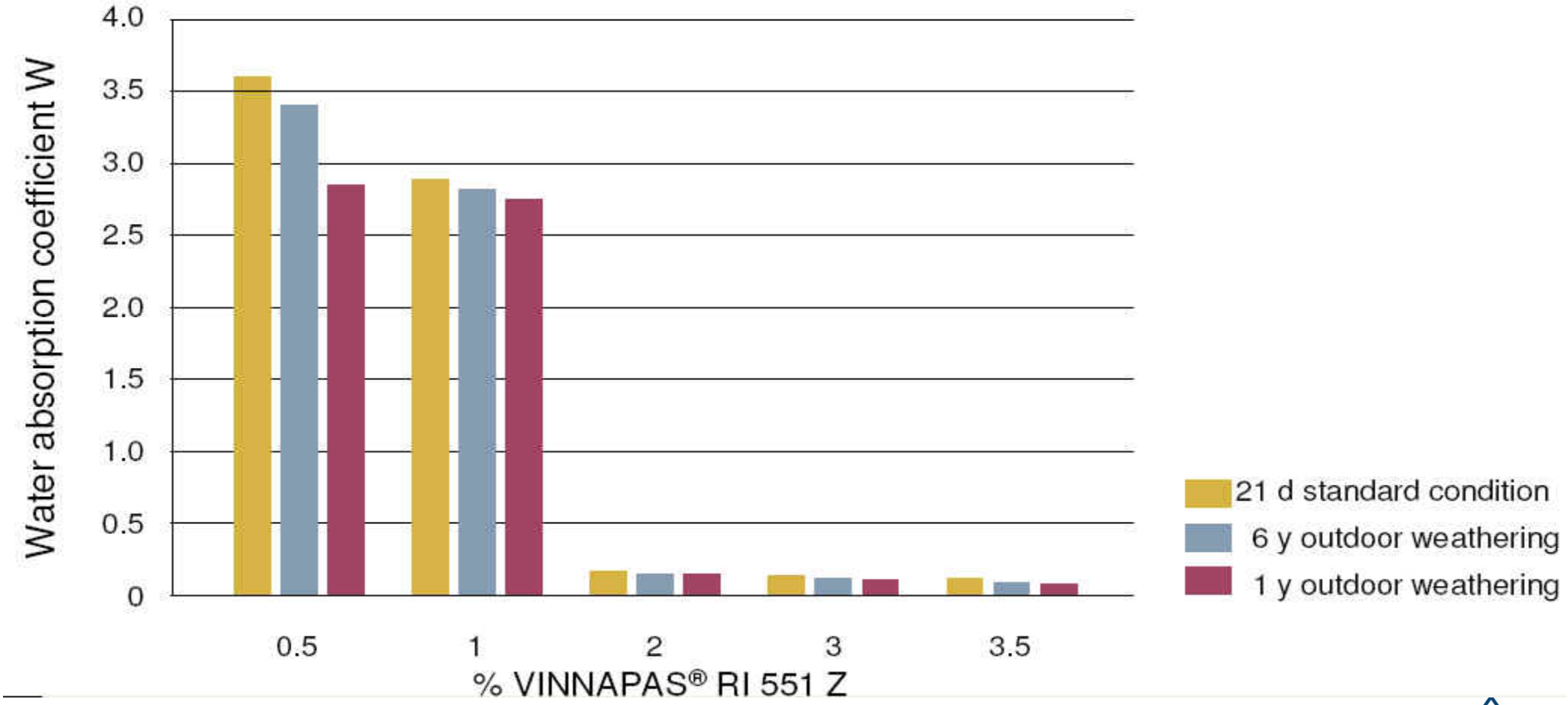
- Synthetic resin-based stucco
- Silicate-based stucco
- Silicone resin-based stucco
- Cement based, polymer modified

Thick-layer plaster

- Cement based, polymer modified

MOST IMPORTANT COMPONENTS TOPCOAT CAPILLARY WATER ABSORPTION

Capillary water absorption of a cementitious plaster for EIFS according to EN ISO 15148



MOST IMPORTANT COMPONENTS INSULATION PANELS

Construction material	Density (kg/m^3)	Thermal conductivity (W/m °C)
Concrete	2088	1.21
Hollow brick	1380	0.73
Plaster	2000	1.20
Air gap	1.25	0.28
Polystyrene boards	24.0	0.04
Roof bricks	1400	0.95
Sand	1450	0.38
Cement tiles	2145	1.35

MOST IMPORTANT COMPONENTS INSULATION PANELS

TECHNICAL PROPERTIES	EXPANDED POLYSTYRENE (EPS)	EXTRUDED POLYSTYRENE (XPS)	MINERALWOOL (MW)
The coefficient of heat conduction“λ”	0,033	0,028 - 0,031	0,040
The coefficient of water vapour resistance ‘’μ’’	20 - 250	8 - 250	1
Flame class	B1 or B2	B1 or B2	Flame proof
Density (Kg/m^3)	≥ 14	≥ 20	8 - 500

MOST IMPORTANT COMPONENTS FLAMMABILITY STANDARDS CLASSIFICATION AS PER EN 13501-1: May 2007

European Flammability Class	Requirement
A1 and A2	No contribution to combustion
B	Very low contribution to combustion
C	low contribution to combustion
D	Acceptable contribution to combustion
E	Acceptable flammability
F	No requirements

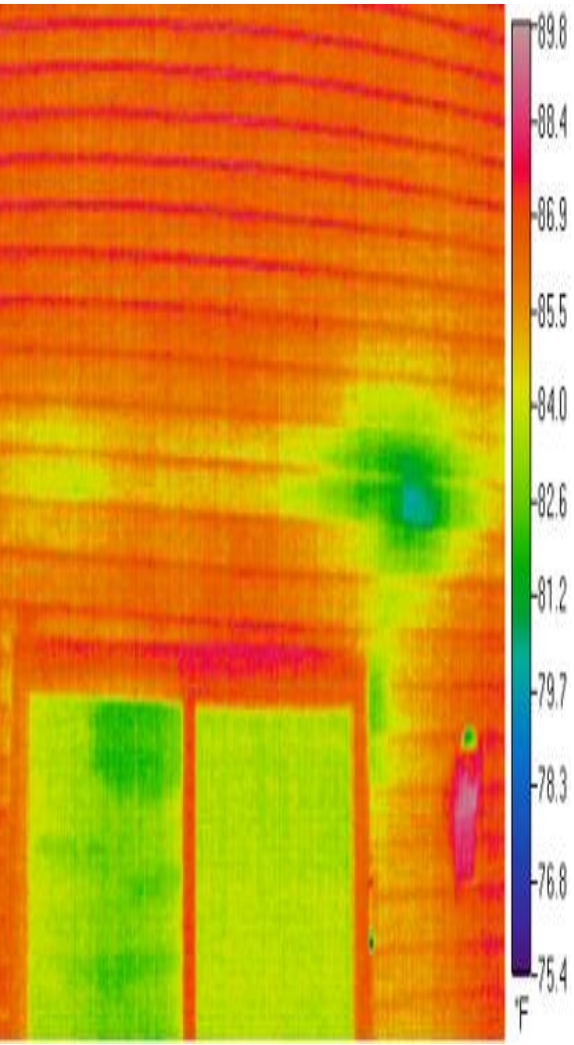
MOST IMPORTANT COMPONENTS
FLAMMABILITY STANDARDS TEST METHODS

Test Method	European Standard
Oven Test (Non flammability test)	EN ISO 1182
Heat Value	EN ISO 1716
Single-Burning-Item Test (SBI)	EN 13 823
[Flooring Radiant Panel]	EN ISO 9239-1
Small Burner Test	EN ISO 11 925-2

MOST IMPORTANT COMPONENTS
DOWEL

- **To be applied 24 h after adhesive has dried.**
- **2 – 4 pc/m² typically in Europe**
- **10 pc/ m² as per Dubai Municipality requirements**
- **Fastening systems such as shot nails, screwed nails or expansion bolts.**
- **Minimum fastener penetration: 7cm for ALC block, 4cm for brick or concrete**

CRITICAL FACTORS
THERMAL BRIDGES



The thermal bridges caused by mechanical fixing devices (anchors) shall be taken into account using the following calculation:

The thermal transmittance of the ETICS must be increased by $\Delta\chi = \chi p.n$

with χp= local influence of thermal bridge caused by an anchor:

χp= 0.004 W/K for anchors with a galvanized steel screw with the head covered by a plastic material.

χp= 0.002 W/K for anchors with a stainless steel screw with the head covered by plastic material, and for anchors with an air gap at the head of the screw.

n= number of anchors per m².

The influence of thermal bridges should be taken into account only if $\Delta\chi > 0.04$ W/m².K.

If the thermal resistance cannot be calculated, it can be measured on the complete system as described in:

- ISO EN 8990 (or pr EN 1934): "Thermal insulation - Determination of steady state thermal transmission properties - Calibrated and guarded hot box".

source ETAG 004 Edition 2004

CRITICAL FACTORS
HUMIDITY

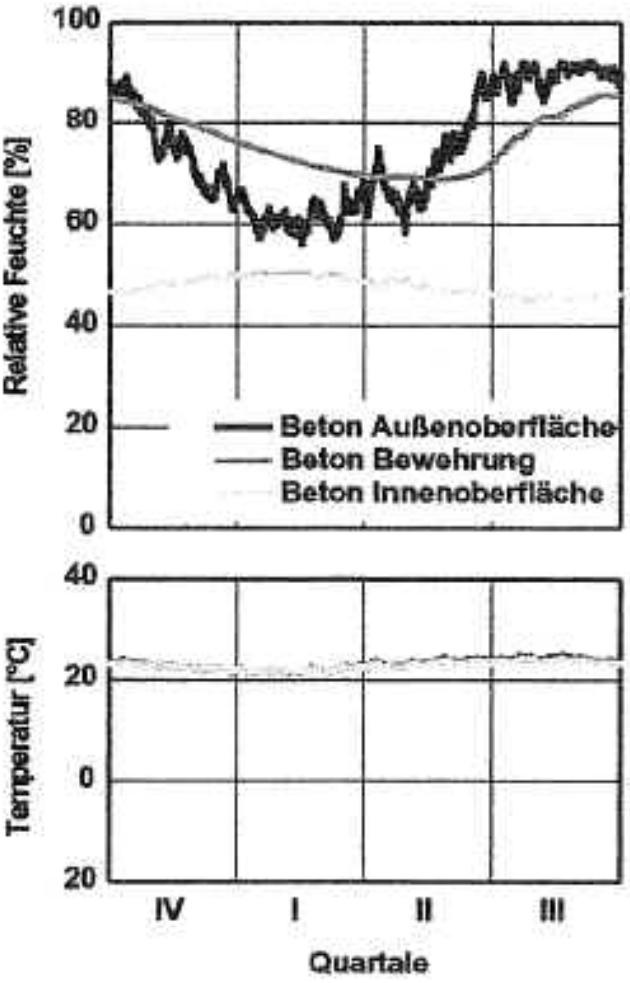


Fig. 2. West facing external wall with ETICS based on mineral wool in Dubai. Calculated temporal variation of the relative humidity and the temperature in the dynamic equilibrium after five years of simulation at three different positions in the concrete: at the exterior surface (interface between concrete and insulation), at the reinforcing steel bar (20 mm beneath exterior surface) and at the interior surface (interface between concrete and interior lining)

- **Water vapour diffusion has to be considered in order to prevent the built up of condensate which can cause damages.**
- **In hot an humid climates with AC a permanent water vapour pressure difference between outside and inside air exists.**
- **High humidity penetrating in the concrete in combination with high temperatures can accelerate carbonation and corrosion of the reinforcement.**

source „WDVS in anderen Klimazonen“ by Dr. Künzel

NORMS AND REGULATIONS

- *The Insulation Requirement by Dubai Municipality (Administrative order No 77 in 2001)*

U value less 0.1 Btu/ °F.ft². h or 0,57 W/(m².K) for walls.

NORMS AND REGULATIONS
THE MOST IMPORTANT GUIDELINE ETAG 004

EUROPEAN ORGANISATION FOR TECHNICAL APPROVALS

European Organization for Technical Approvals

ETAG 004

Guideline for European Technical Approvals
for
External Insulation and Finish Systems

STANDARDS AND NORMS

Tests	Standards	Test methods	Requirements
Guideline for EIFS approval	ETAG 004	Assessment of whole system	Yes
Tensile adhesive strength of adhesive and embedding mortars on polystyrene	ETAG 004	Adhesion test on polystyrene boards	> 0.08 N/mm^2
Crack test	Ö-Norm B 6110	Wedge test	No cracks up to 5 mm thickness
Drop test	EOTA, (concept) WACKER method	Steel ball falls on EIFS	Impact energy > 3 J
Flexural and compressive strength	DIN 18555/3	Prisms, 4 x 4 x 16 cm^3	No
Capillary water absorption	ETAG 004 EN ISO 15148	Water absorption of an embedding mortar and decorative topcoat on an insulation panel after 24h	< 0.5 kg/m^2

NEW EOTA RIG
BETTER SERVICE FOR OUR CLIENTS

Two individual walls at the climate chamber tested at the same time

(appr. 24 tests/year)

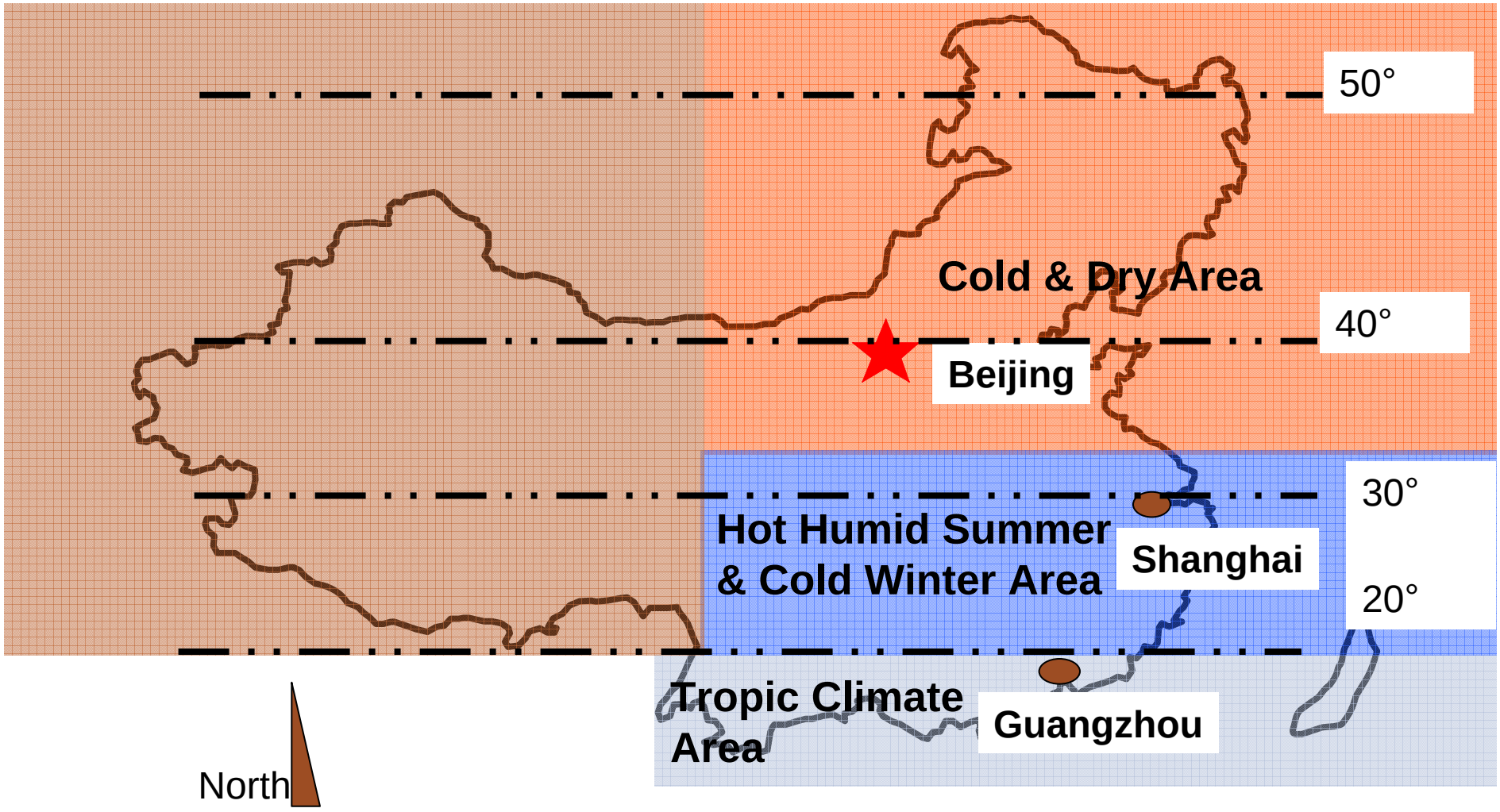
Test wall preparation for the hygro-thermal test

STANDARDS AND NORMS (EOTA WALL) (ETAG 004 5.1.3.2.1)

EOTA (ETAG 004 – WWW.EOTA.BE)

80 hygrothermal cycles	3 h 70 °C- 10 % humidity, 1 h rain at 15 °C, 2 h without exterior influence at 15 °C (Drainage)
5 heat / freeze cycles	8 h 50 °C 16 h -20 °C
Visuell inspection during and after the testprogram	Blisters, delamination, fine cracks, crawling,
Tests after finishing the cycles on the testwall	
Adhesion on the base coat	> 0,08 N/mm²
Impact resistance (steel ball test) 3 Categories	< 3 J, 3 – 10 J, > 10 J.
Perfortest Resistance against perforation of the system, if thickness of layer lower than 6 mm	not specified

TESTING THE EFFECTS OF EIFS UNDER PRACTICAL CONDITIONS IN DIFFERENT CLIMATIC ZONES IN CHINA



ONE YEAR MODEL HOUSE PROJECT WITH CHINESE UNIVERSITIES PROVES EFFECTIVENESS OF EXTERIOR INSULATION FINISHING SYSTEMS

Beijing
北京

North

Shanghai
上海

East

Guangzhou
广州

South

Aim

Prove effectiveness of EIFS to the Chinese building industy under the existing climatic conditions

Approach

- Two identical model houses – one with, one without EIFS – in Beijing, Shanghai, Guangzhou
- Cooperation with Customers to build houses
- Cooperation with the Universities Tsing Hua, Tongji and South China Science & Technology for data collection and interpretation
- Spreading message in seminars, media, to associations, government etc.

Time line

Oct. 2002 – Oct. 2003

SAMPLES HOUSES WITH AND WITHOUT EIFS

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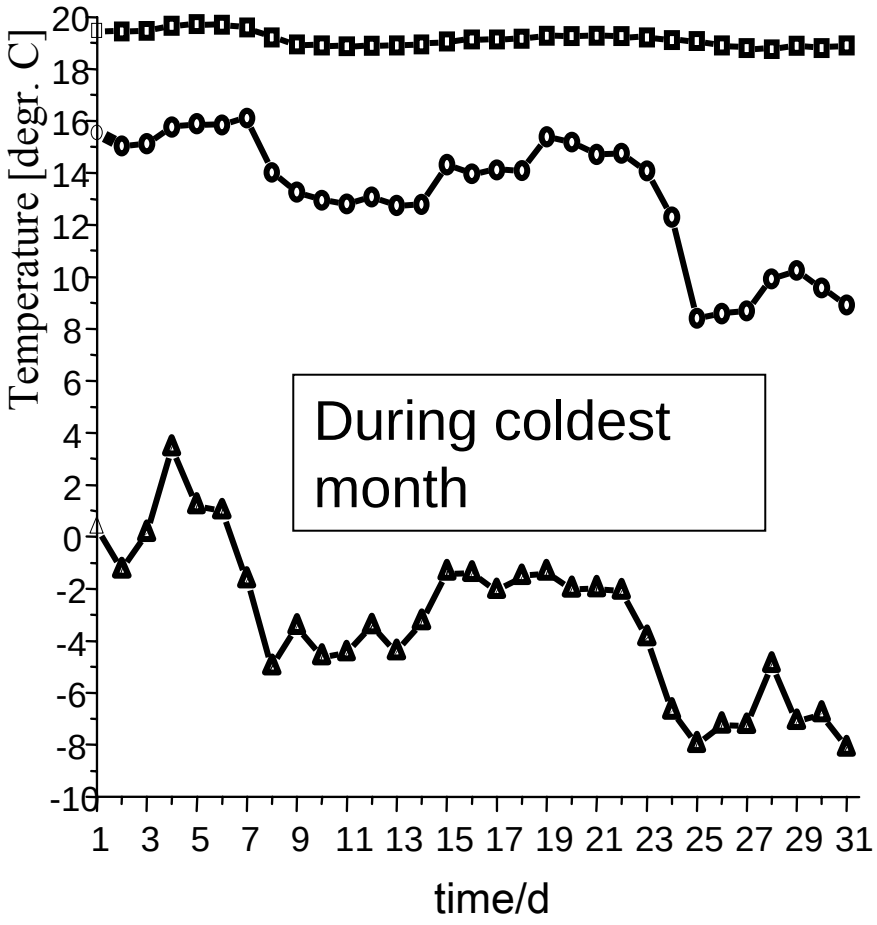
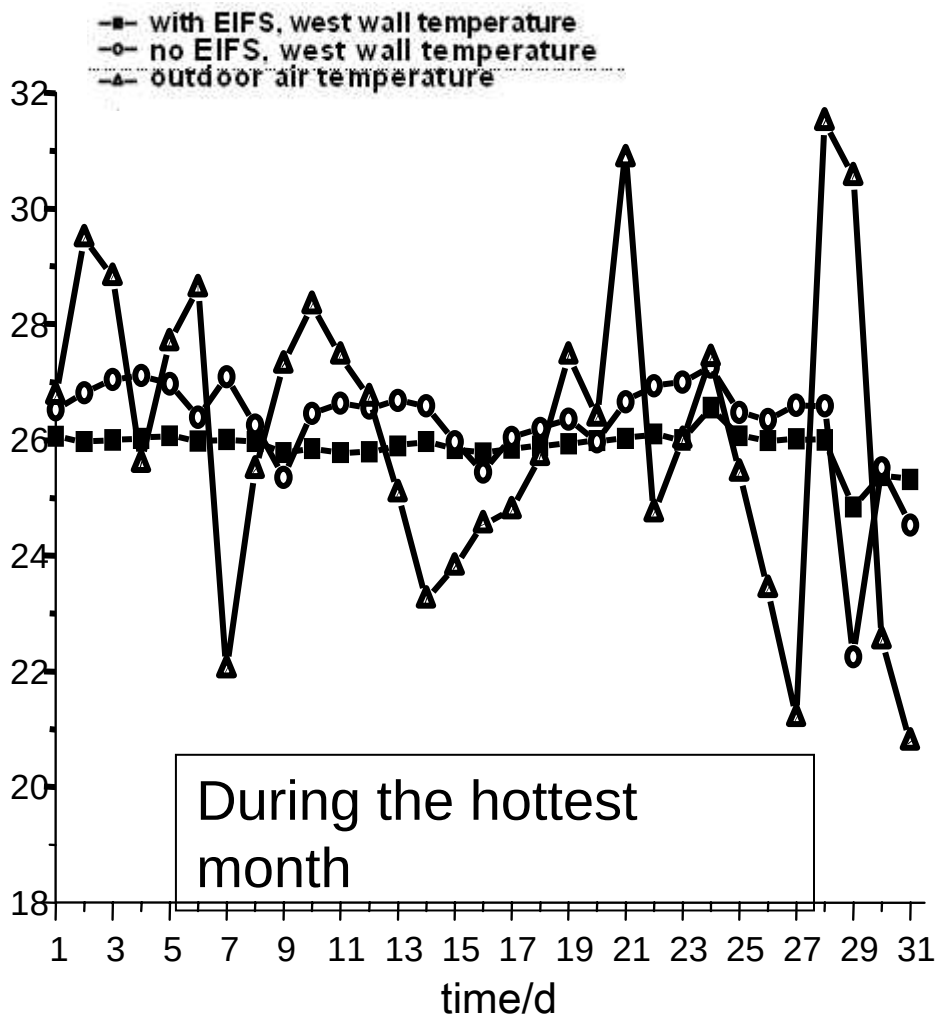
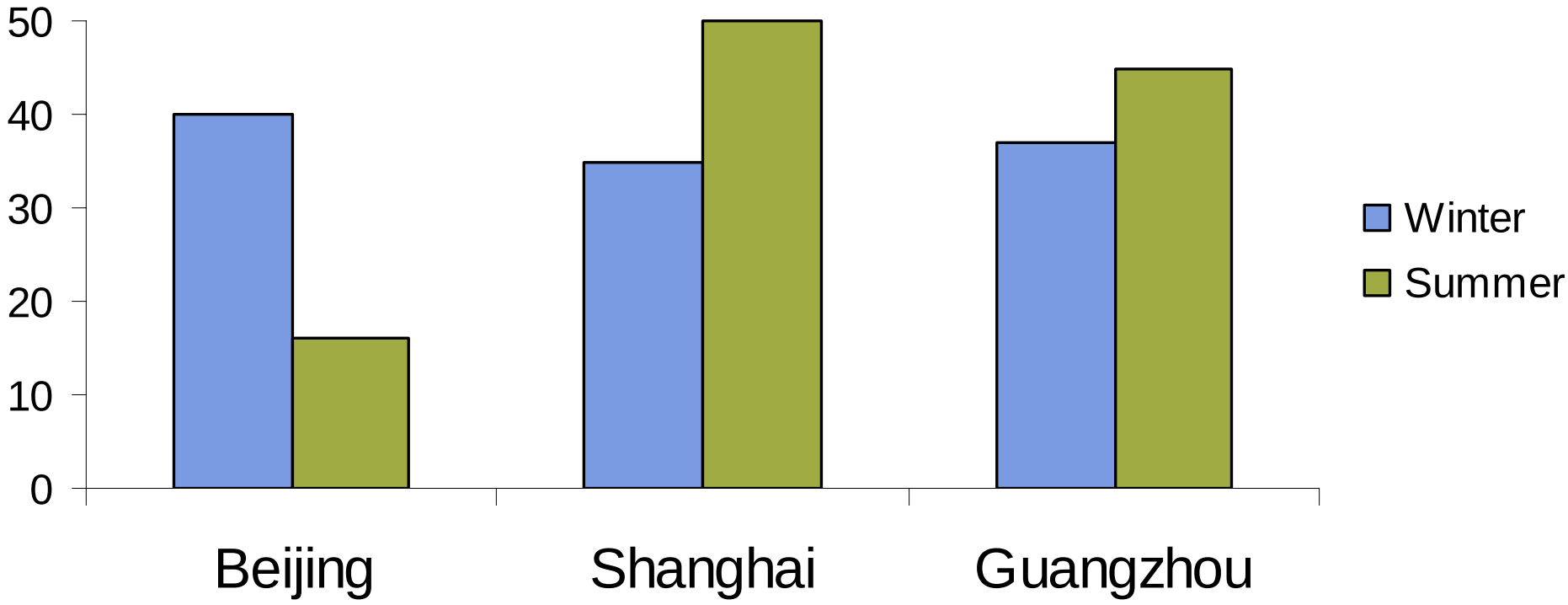
TEMPERATURE VARIATIONS INSIDE THE MODEL HOUSES WITH AND WITHOUT EIFS DURING THE COLD AND HOT SEASON IN CHINA





EIFS ACHIEVE CONSIDERABLE REDUCTION OF ENERGY USED TO HEAT AND COOL IN THREE DIFFERENT CLIMATIC ZONES

Average reduction of electricity consumption in %,
Oct. 2002- Oct. 2003



COST MODEL
ENERGY SAVING CALCULATION

- Consider a house of 200 m² **without** EIFS

Media	Thickness (m)	U value (W/m²k)	Thermal Resistance
Brick wall	**0.24**	**2.29**	**= 0.24/ 2.29 = 0.104**
Normal Plaster	**0.015**	**0.50**	**= 0.015/0.50 = 0.03**

- The Total Thermal Resistance = 0.104+0.03 = 0.17 m².K/W
- Total U value = 1/ 0.17= 5.8823 W/mk
- Heat loss = U * Area * dT(standard temp difference) = 5.8823* 200 * 17 = **20000 W**

COST MODEL
ENERGY SAVING CALCULATION

- Consider a house of 200 m² **with** EIFS

Media	Thickness (m)	U value (W/m²k)	Thermal Resistance
Brick wall	**0.24**	**2.29**	**= 0.24/ 2.29 = 0.104**
Normal Plaster	**0.015**	**0.50**	**= 0.015/0.50 =0.03**
EIFS	**0.15**	**0.33**	**= 0.15/ 0.33 = 0.45**

- The Total Thermal Resistance = 0.104+0.03 + 0.45 = 0.548 m².K/W
- Total U value = 1/ 0.548 = 1.71 W/m²k
- Heat loss = U * Area * dT(standard temp difference)= 1.71* 200 * 17 = **5821 W**

COST MODEL
ENERGY SAVING CALCULATION

- **Conclusion:** The Energy Saving between the two cases

  = 20000- 5821 = 14718 W

- In average you can save between 60-70 % of the heating oil required.


THANK YOU VERY MUCH FOR YOUR ATTENTION!