POLYMER MODIFIED CEMENTITIOUS SYSTEMS

Odile Quet

13.9.2005

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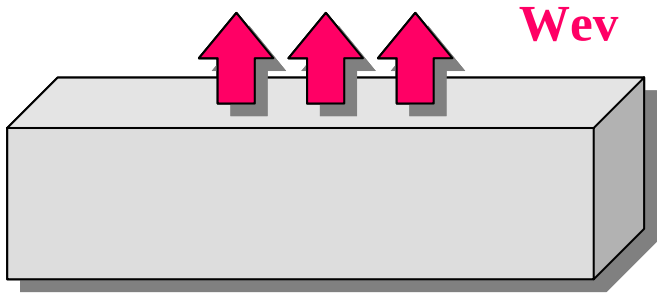
WHY TO USE A CEMENT MODIFIER ?

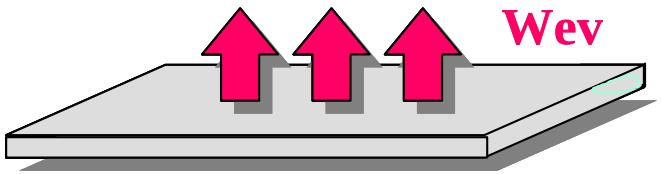
Concrete



S, V, W/C

Thickness:	**>10 cm**
Drop in w/c	**Wev / C**
Drop on properties	***Limited***

Repair mortars, renders, ceramic tile adhesives..



S, v, w/c (=W/C)

Thickness:	**<1cm**
Drop in w/c	**Wev /c**
Drop on properties	***MARKED***

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MAIN PROPERTIES OF POLYMER MODIFIED SYSTEMS

	Unmodified Concrete	Polymer Modified Cementitious systems
• *System structure*	inorganic matrix	inorganic matrix *+ organic binder*
• *Main properties*	high compressive strength	• high flexural strength • high adhesion • high impact resistance • waterproof ness • chemical resistance

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RELEVANT RATIOS IN CEMENTITIOUS SYSTEMS

RATIO	PROPERTIES	RELATIONSHIP
Sand/Cement (**s/c**)	Dimensional stability (Shrinkage : SH)	SH = f (1 / (**s/c**))
Water/Cement (**w/c**)	Strength (Compressive strength : S)	S = f (1 / (**w/c**)2)
Polymer/Cement **(p/c)**	Cohesion / Adhesion (Flexural strength : FS)	FS = f (**p/c**)

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ADVANTAGES OF POLYMER MODIFIED SYSTEMS

- **Good workability at lower water level**
- **Improved adhesion to a variety of substrates**
- **Increased flexural strength**
- **Improved toughness**
- **Resistance to ion permeability**
- **Outstanding durability….**

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IMPACT OF POLYMER LEVEL ON FINAL PROPERTIES
(polymer modification level = 15%)

Mechanical Properties	Factor of Improvement
Water / Cement	-20%
Compressive Strength	unchanged
Flexural Strength	X 2
Tensile Strength	X 2.5
Impact Strength	X 2
Adhesion	X 10
Abrasion Resistance	X 30

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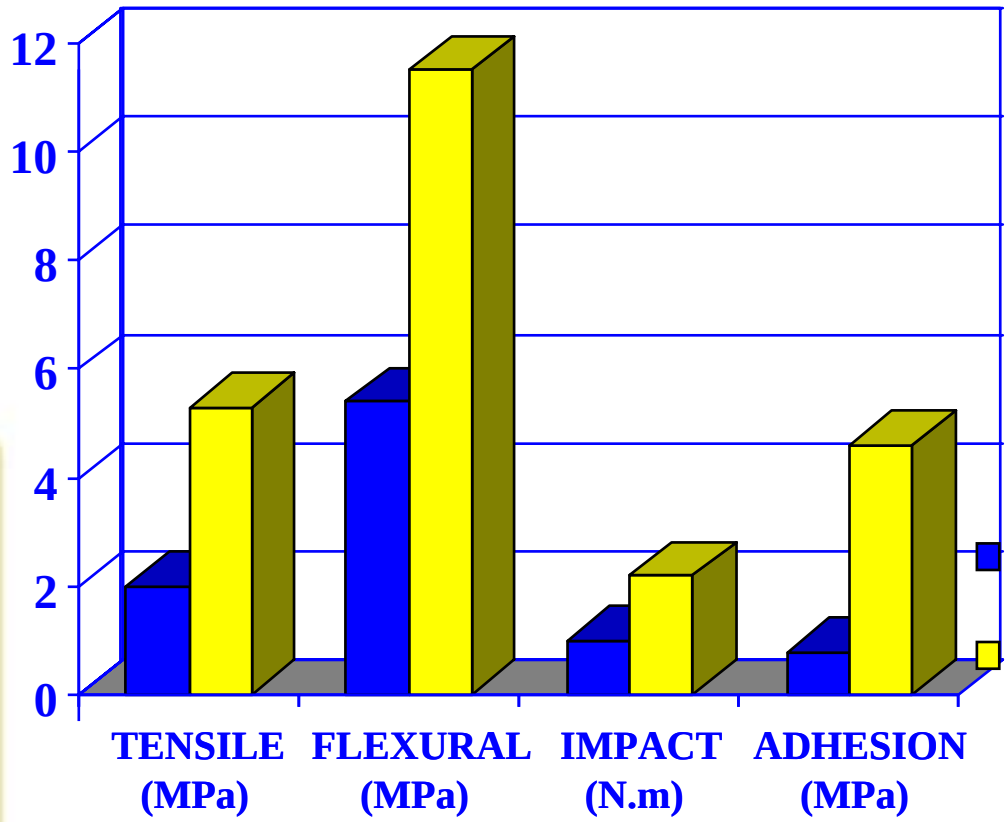
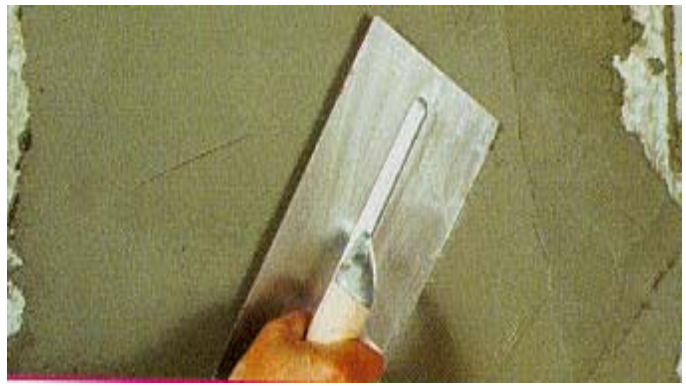
IMPACT OF ACRYLIC POLYMERS ON CEMENT STRENGTH PROPERTIES





unmodified

15% polymer modified

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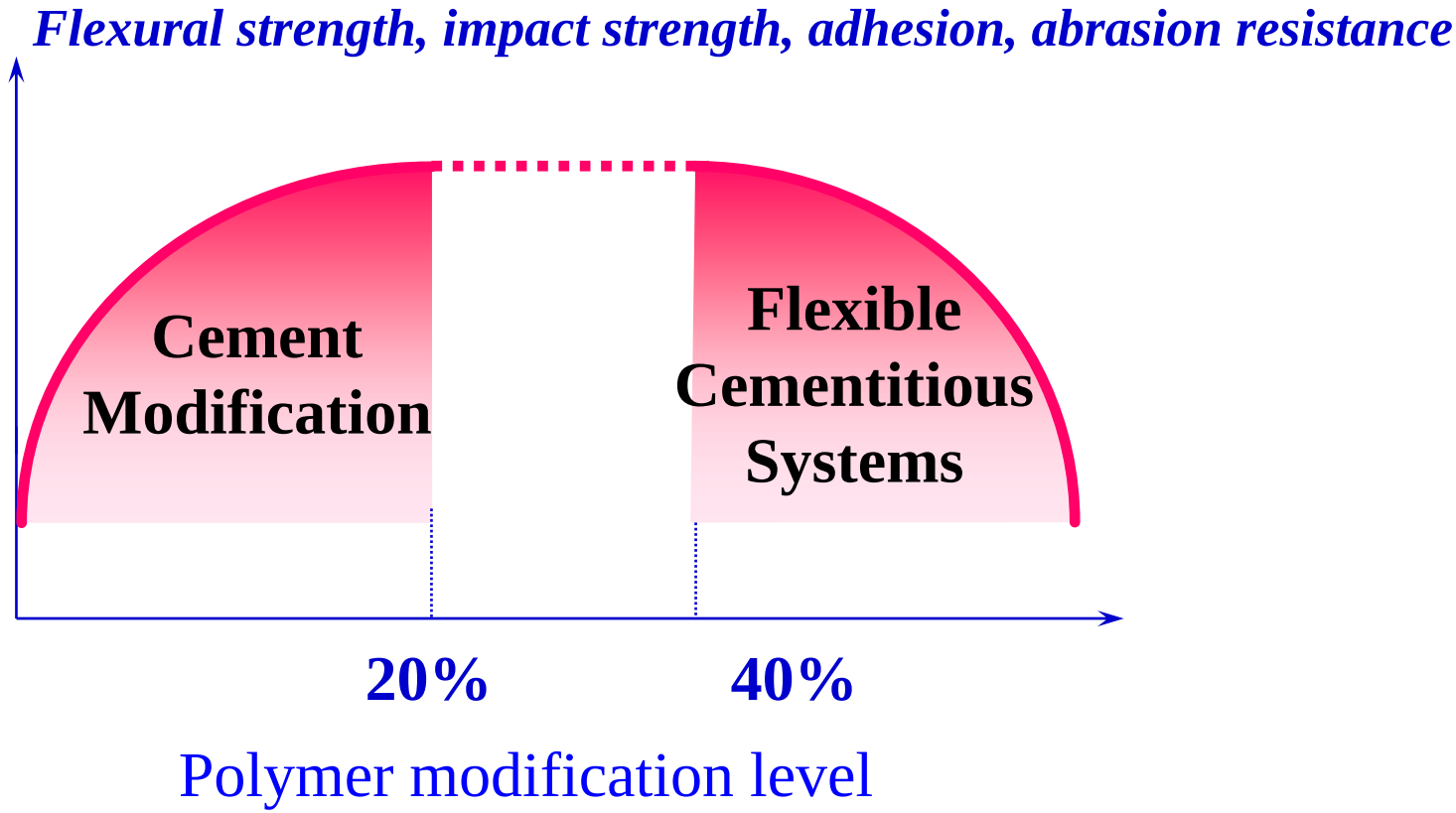
IMPACT OF POLYMER MODIFICATION LEVEL



CEMENT MODIFIERS APPLICATION AREAS

- **Repair mortars**
- **Self leveling flooring systems**
- **Cementitious flexible water proofing membranes**
- **Ceramic Tile Adhesives**
- **Cementitious paints**
- **Tile grouts**
- **Floor screeds**
- **Glass reinforced concrete**
- **EIFS (Exterior Insulation Finishing systems)**

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CEMENTITIOUS SYSTEMS FORMULATION
PRINCIPAL ADDITIVES

Nature	**Function**
Accelerators	Accelerate Cement Set
Retarders	Delay Cement Set
Superplasticizers	Dispersant of Cement
Thickener	Rheology Adjustement
Defoamer	Foam Control (mechanical performances)
Air Entrainer	Foam Control (rheology)
Water Repellent	Water Resistance Adjuster
Water Retention Aid	Water Evaporation Rate Control
Fibers	Stress Absorber
Reactive Fillers	Shrinkage Control - Water Retainer
Solvents	Coalescent - Anti-freeze agent

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SELF-LEVELLING AREA

Issues...

- **Flow / reflow**
- **Set time**
- **Adhesion**
- **Abrasion Resistance**
- **Dimensional stability**

CERAMIC TILE ADHESIVES (CTA)

Issues...

- **Workability / Open Time**
- **Water Resistance**
- **Flexibility**
- **Adhesion**

REPAIR MORTARS

Supports anciens

Issues...

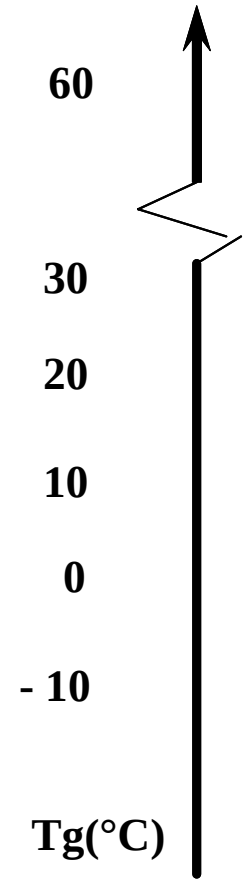
- **Workability**
- **Flexural strength**
- **Adhesion**
- **Dimensional stability**

FLEXIBLE CEMENTITIOUS MEMBRANES

Issues...

- **Flexibility**
- **Waterproof ness**
- **Tensile strength**
- **tear resistance**

CEMENT MODIFIERS PRODUCT RANGE



Primal E-357 EF

Primal AC-339

Primal E-330 EF

Primal SF-016 ER

Primal AS-48

Limited to :
- **Concrete roof tiles**
- **Fiber cement**

- **Suitable to all cement modification application areas**

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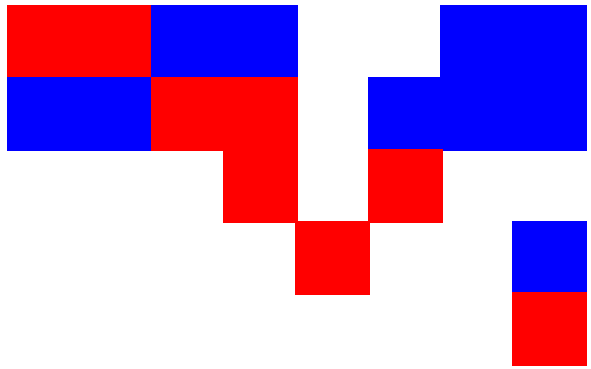
PRODUCT RANGE BY APPLICATION

		CHARACTERISTICS				END USE							
		CHEMICAL NATURE	SOLIDS (%)	MFT (°C)	PROPERTIES	PATCHING	FLOORING	EIFS	2 - K CTA	PASTE CTA	FLEXIBLE MEMBRANES	PGRC	PRIMER
	EMULSIONS												
PRIMAL	E-330 EF	Ac	47	10	General purpose								
	SF-016 ER	Ac	50.5	0	Low MFT								
	AS-48	St/Ac	56	-3 (Tg)	Flexibility								
	CM-219EF	St/Ac	50	20	H20 resistance								
	AC-339	Ac	48	30	Sealing								



: Highly recommended

: Suitable

PRIMAL E-330 EF IN BASIC REPAIR MORTAR

COMPOSITION

	Composition (pbw)	Ratios
Portland cement	100	
Sand (ASTM C-109)	250	. Sand/cement = 2.5
Polymer solids	10	. Polymer/cement = 10%
Total water	35	. Water/cement = 35% (Unmodified : 48%)
Defoamer	0.2	. Defoamer/polymer = 2%

PROPERTIES

	Primal E-330 S	Primal E-330 EF	Unmodified
Mortar characteristics			
W/C (%)	**35**	**35**	**48**
Flow (mm)	**167**	**177**	**172**
Set time (min)	**315**	**340**	**285**
Mechanical properties (23°C/50% RH)			
Compressive strength (MPa)			
1 day	**17.4**	**17.7**	**14.8**
2 days	**22.8**	**23.3**	**16.5**
7 days	**30.0**	**29.2**	**20.8**
Flexural strength (MPa)			
7 days	**8.5**	**9.0**	**4.2**
Shear-bond adhesion on concrete (MPa)			
7 days dry	**3.5**	**4.0**	**0.7**
7 days dry / 7 days wet	**3.6**	**4.7**	**0.7**

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PRIMAL SF-016 ER AS A CEMENT MODIFIER

FORMULA	
Standard sand	1350
Cement CP II/A 52.5	450
Water	119.2
Emusion	96.8
Nopco NXZ	1.75

	E-330 EF	SF-016 ER
Retardation effect		
1 day compressive strength (MPa)	7.5	7.1
Flexural strength		
7 days flexural strength (MPa)	9.7	8.4
28 days flexural strength (MPa)	15.1	12.7
Compressive strength		
7 days compressive strength (MPa)	33.5	31.6
28 days compressive strength (MPa)	44.1	36.9
Adhesion on concrete		
28 days dry (MPa)	6.18	4.90

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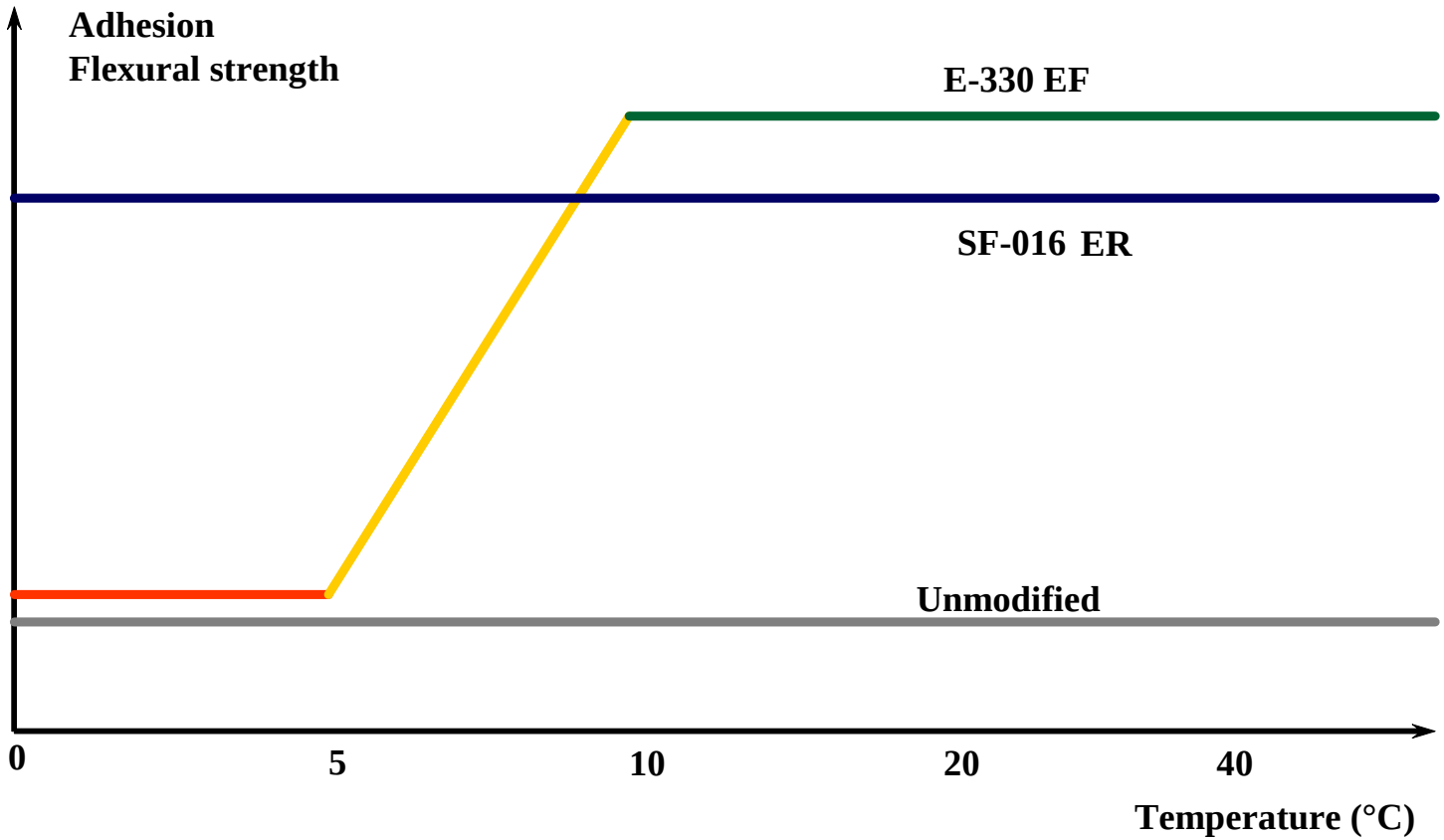
SF-016ER VERSUS E-330 EF



AS-48 - FLEXIBLE CEMENTITIOUS MEMBRANE FOR WATER TANKS

Formulation

Ingredients	Solids (%)	Parts (g)
Dry Mix		
Sand F-15	-	26.6
Sand F-25	-	39.9
Talc de Luzenac n°2	-	3.5
Cement CEM I/A 52,5	-	30
Culminal MHEC 40000P (thickener)	-	0.1
Arbocel FWC-500 (fibers)	-	0.5
Peramin 3181 (dispersant)	40	0.85
Polymer Modification : AS-48	56	29.4
Water	-	4
Nopco NXZ (defoamer)	-	0.25
Ratios		
P/C	-	0.55
W/C	-	0.56

Curing cycles

7 days DRY : CTR : 23°C / 50% RH
7 days DRY : CTR : 23°C / 50% RH + 7 d Water immersion
7 days DRY : CTR : 23°C / 50% RH + 7 d Water immersion + 14d DRY
14d DRY measured at -10°C

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AS-48 - FLEXIBLE CEMENTITIOUS MEMBRANE FOR WATER TANKS

Flexibility Measurements

Measurements done on MTS dynamometer; 23°C-50%RH; traction speed = 50mm/min.

Polymer Matrix		AS-48	Comm.1	Comm.2
Elongation at break (%)	Dry cure	22	40	16
	Wet Cure	11.4	15.2	11.8
	Dry + Wet + Dry	17.5	33.4	10.8
	14d D tested at -10°C	7.1	6	17.1
Strength max (MPa)	Dry cure	1.7	0.9	1.1
	Wet Cure	0.7	0.4	0.4
	Dry + Wet + Dry	2.7	1.1	1.5
	14d Dry -10°C	8.9	7.5	2.5
Modulus of elasticity (MPa)	Dry cure	37.5	17.9	18.6
	Wet Cure	13.2	7.6	4.6
	Dry + Wet + Dry	55.9	20.2	30.3
	14d Dry -10°C	479	523	41

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PRIMAL AS-48
Scale up in Europe

- 1rst batch successfully scaled up in Tudela
- Started process to modify the binder for food approval and drinking water approval
- Target : end of 2005

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