

INSTITUT
GÉOPOLYMÈRE

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Ralph Davidovits
Abrar Gasmi
Francesco Volpintesta



TemPozz Metakaolins

**The best metakaolins ever tested
mechanical strengths x3
reduce the cost of geopolymer by 30%**

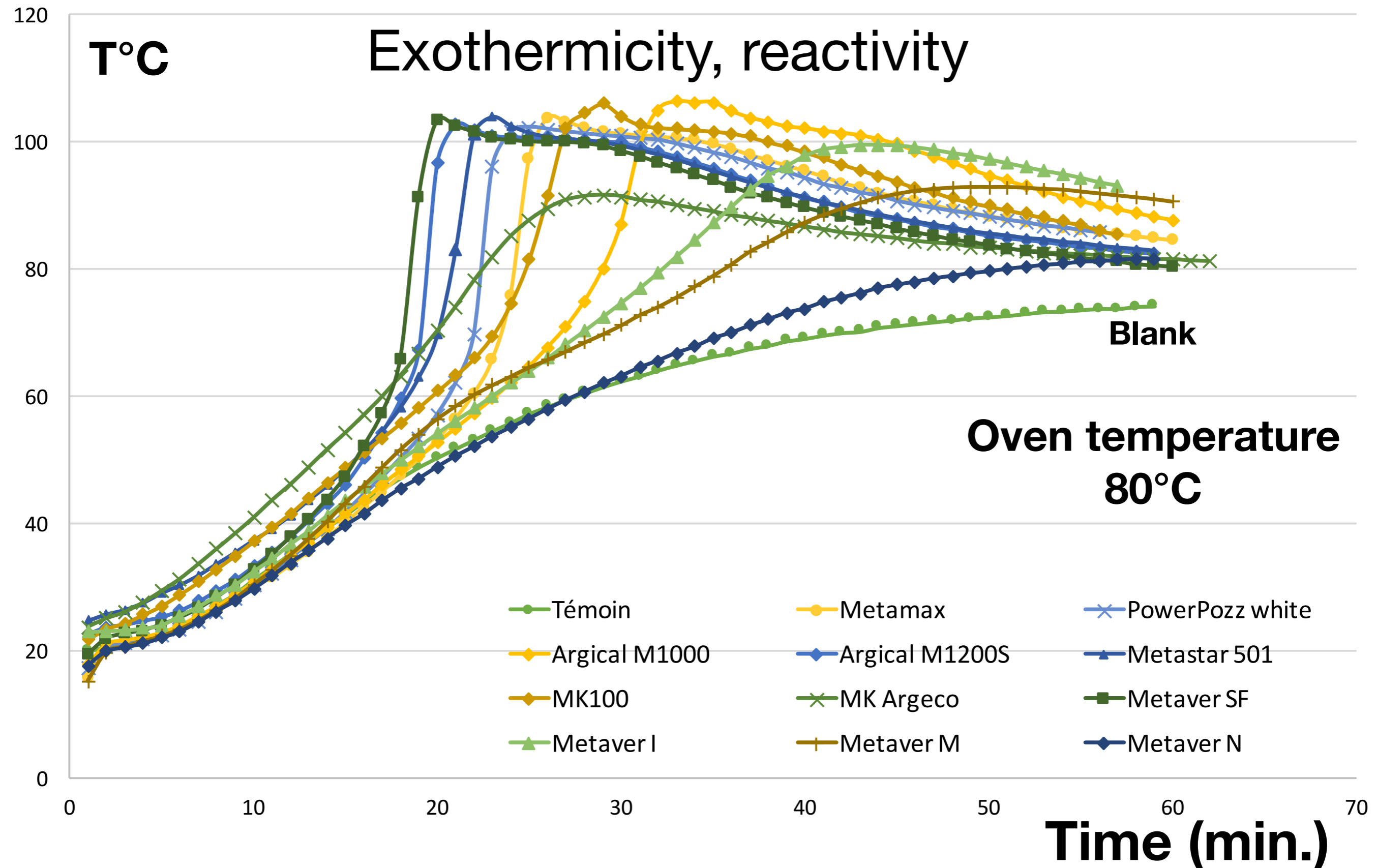
Product	temPozz	C90	C90f	M86	M88	M92
Calcination technique		flash	flash	flash	flash	flash
Colour	L	89,3	91,1	86,6	88,1	91,6
	a	0,4	-0,2	0,7	0,4	0,7
	b	2,1	1,4	2,8	2,7	3,4
Chapelle value	mg Ca(OH) ₂ /g	1 200	1 300	1 200	1 300	1 400
Particle distribution	d10	1 µm	1 µm	1 µm	1 µm	1 µm
	d50	5 µm	2 µm	5 µm	3 µm	3 µm
	d90	15 µm	10 µm	15 µm	10 µm	10 µm
Chemical composition	SiO ₂	~52	~52	~54	~54	~54
	Al ₂ O ₃	~45	~45	~43	~43	~43
	Fe ₂ O ₃	<0,5	<0,5	<1,0	<1,0	<1,0
	TiO ₂	<0,8	<0,8	<1,2	<1,2	<1,2
	CaO	<0,5	<0,5	<0,5	<0,5	<0,5
	MgO	<0,2	<0,2	<0,2	<0,2	<0,2
	K ₂ O	<0,1	<0,1	<0,1	<0,1	<0,1
	Na ₂ O	<0,2	<0,2	<0,2	<0,2	<0,2

Reactivity test, observing exothermicity



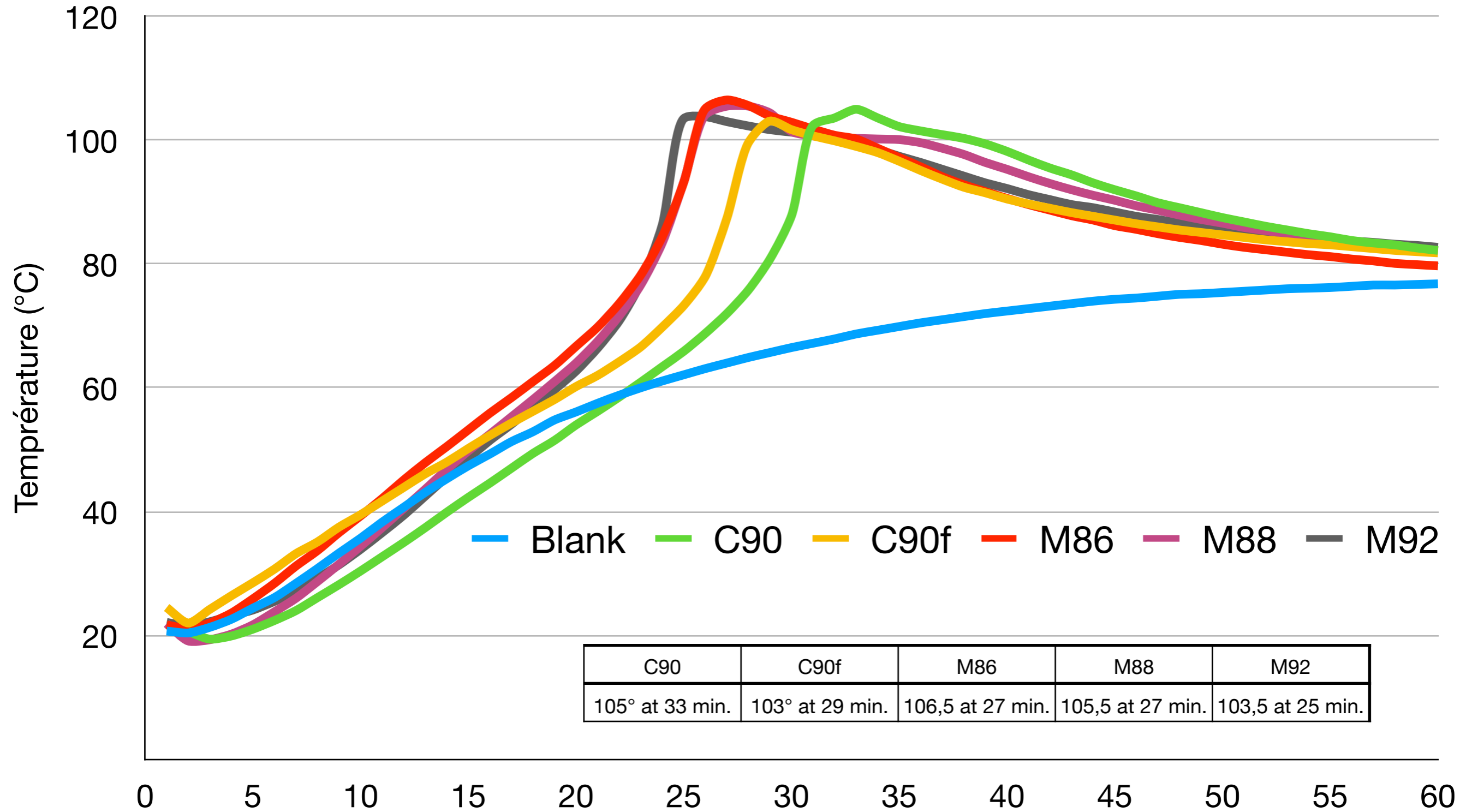
Sample: 100 g of K-silicate MR=1.7, 60 g of metakaolin,
10 min. mixing, 1 hour at 80°C
Blank: 55 g of water, 60 g of metakaolin

Testing of 10 commercial metakaolins



Metaver SF (21 min., 103 °C)
Argical M1200 (22 min., 103 °C)
PowerPozz White (26 min., 103 °C)
MetaMax (27 min., 103 °C)
MK Argeco (30 min., 93 °C)
Argical M1000 (34 min., 106 °C)
MK Pink (34 min., 106°C)
Metaver I (45 min., 100 °C)
Metaver M (50 min., 93 °C)
Metaver N (60 min., 82 °C)
MK 1300 (60 min., 80 °C).

Reactivity Test TemPozz Metakaolins



Product	temPozz	C90	C90f	M86	M88	M92
Calcination technique		<i>rotary kiln</i>	<i>rotary kiln</i>	<i>rotary kiln</i>	<i>rotary kiln</i>	<i>rotary kiln</i>
Colour	L	89,3	91,1	86,6	88,1	91,6
	a	0,4	-0,2	0,7	0,4	0,7
	b	2,1	1,4	2,8	2,7	3,4
Chapelle value	mg Ca(OH) ₂ /g	1 200	1 300	1 200	1 300	1 400
Geopolymer Method	Reactivity	105° at 33 min.	103° at 29 min.	106,5 at 27 min.	105,5 at 27 min.	103,5 at 25 min.
Particle distribution	d10	1 µm	1 µm	1 µm	1 µm	1 µm
	d50	5 µm	2 µm	5 µm	3 µm	3 µm
	d90	15 µm	10 µm	15 µm	10 µm	10 µm
Chemical composition	SiO ₂	~52	~52	~54	~54	~54
	Al ₂ O ₃	~45	~45	~43	~43	~43
	Fe ₂ O ₃	<0,5	<0,5	<1,0	<1,0	<1,0
	TiO ₂	<0,8	<0,8	<1,2	<1,2	<1,2
	CaO	<0,5	<0,5	<0,5	<0,5	<0,5
	MgO	<0,2	<0,2	<0,2	<0,2	<0,2
	K ₂ O	<0,1	<0,1	<0,1	<0,1	<0,1
	Na ₂ O	<0,2	<0,2	<0,2	<0,2	<0,2

Pot Life

- Super long pot-life compared to the competitions
M86, M88, M92, C90f = 8 hours
C90 = 16 hours !!!
=> This reactivity determines which type of applications
- M1200S = 25 minutes (Flash calcined)
Metamax = 3 h 30 (rotary kiln)
M1000 = 6 hours (rotary kiln)
PowerPoz = 8 hours (rotary kiln)

Mechanical Strength

- **Reference Potassium Silicate**

K-Silicate Woellner Geosil K 14517 = 75g

Metamax = 39,81g

Feldspar 63 μ m Iméryys = **91g**

- **Reference Sodium Silicate**

Na-Silicate Woellner Geosil Na 34417 = 75g

Metamax = 47,61g

Feldspar 63 μ m Iméryys = **74g**

Flexural Strength: **15 MPa**

Flexural Strength = bonding between MK and filler

Cured in the oven at 80°C for 24 hours

Mechanical Strength

Potassium-based

- **C90:**
Geosil K 14517 = 75g - C90 = 38,75g - Feldspar **131g (+44%)**
Flexural Strength: **16,1 MPa (+7%)**
- **C90f:**
K-Silicate = 75g - C90f = 38,75g - Feldspar **161g (+77%)**
Flexural Strength: **17,3 MPa (+15%)**
- **M86:**
K-Silicate = 75g - M86 = 40,55g - Feldspar **136g (+50%)**
Flexural Strength: **15,7 MPa (+5%)**
- **M88:**
K-Silicate = 75g - M88 = 40,55g - Feldspar **151g (+66%)**
Flexural Strength: **18,4 MPa (+23%)**
- **M92:**
K-Silicate = 75g - M92 = 40,55g - Feldspar **151g (+66%)**
Flexural Strength: **16,1 MPa (+7%)**

Mechanical Strength

Sodium-based

- **C90:**
Geosil Na 34417 = 75g - C90 = 46,34g - Feldspar **105g (+42%)**
Flexural Strength: **15,4 MPa (+3%)**
- **C90f:**
Na-Silicate = 75g - C90f = 46,34g - Feldspar **95g (+28%)**
Flexural Strength: **20,7 MPa (+38%)**
- **M86:**
Na-Silicate = 75g - M86 = 48,49g - Feldspar **125g (+70%)**
Flexural Strength: **18,4 MPa (+23%)**
- **M88:**
Na-Silicate = 75g - M88 = 48,49g - Feldspar **115g (+55%)**
Flexural Strength: **21,1 MPa (+41%)**
- **M92:**
Na-Silicate = 75g - M92 = 48,49g - Feldspar **120g (+62%)**
Flexural Strength: **18,6 MPa (+24%)**

Mechanical Strength

	K-Silicate Binder	Feldspar Filler	Na-Silicate Binder	Feldspar Filler
Metamax Reference	15 MPa	91g	15 MPa	74g
C90	16,1 MPa (+7%)	131g (+44%)	15,4 MPa (+3%)	105g (+42%)
C90f	17,3 MPa (+15%)	161g (+77%)	20,7 MPa (+38%)	95g (+28%)
M86	15,7 MPa (+5%)	136g (+50%)	18,4 MPa (+23%)	125g (+70%)
M88	18,4 MPa (+23%)	151g (+66%)	21,1 MPa (+41%)	115g (+55%)
M92	16,1 MPa (+7%)	151g (+66%)	18,6 MPa (+24%)	115g (+55%)

First Conclusions

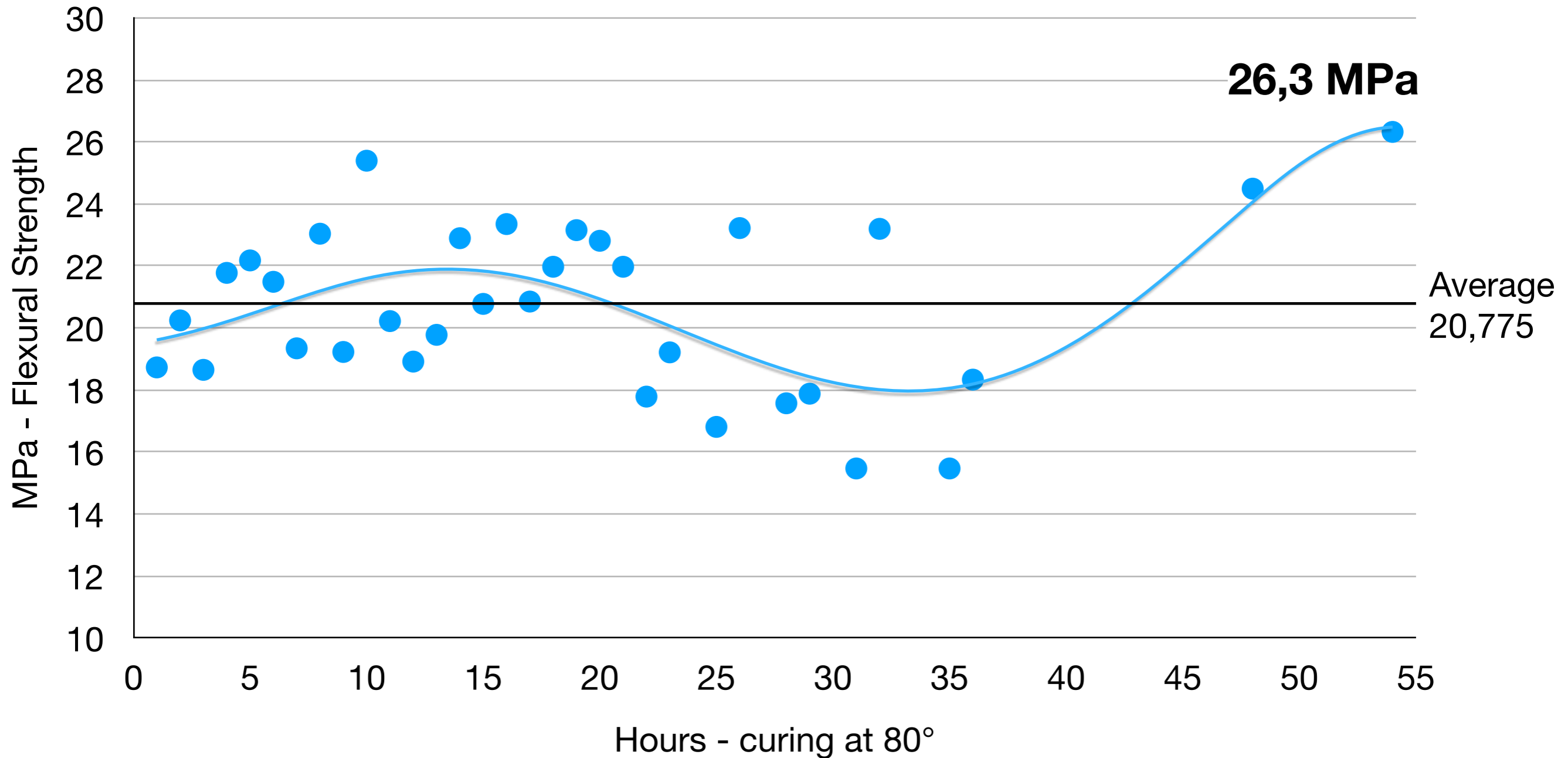
- Super fluid Metakaolin
- Extremely long pot-life
- It “wets” the fillers so well ! Adding so much amount of fillers is **exceptional**. No other MKs give such advantages!!!
 - > Lower the cost of the final item by adding cheaper fillers
 - > More fillers provide better mechanical strengths
- But we were wrong in curing the material for 24 hours. It was not enough. It is not the optimal strength.

Finding the optimum

- Their reactivity, or speed of reactivity, are much slower compared to the other well-known MKs.
- Instead of 24 hours at 80°, the optimum setting time is 48 hours (2 days) with K-Silicate, 60 to 72 hours (3 days) with Na-Silicate

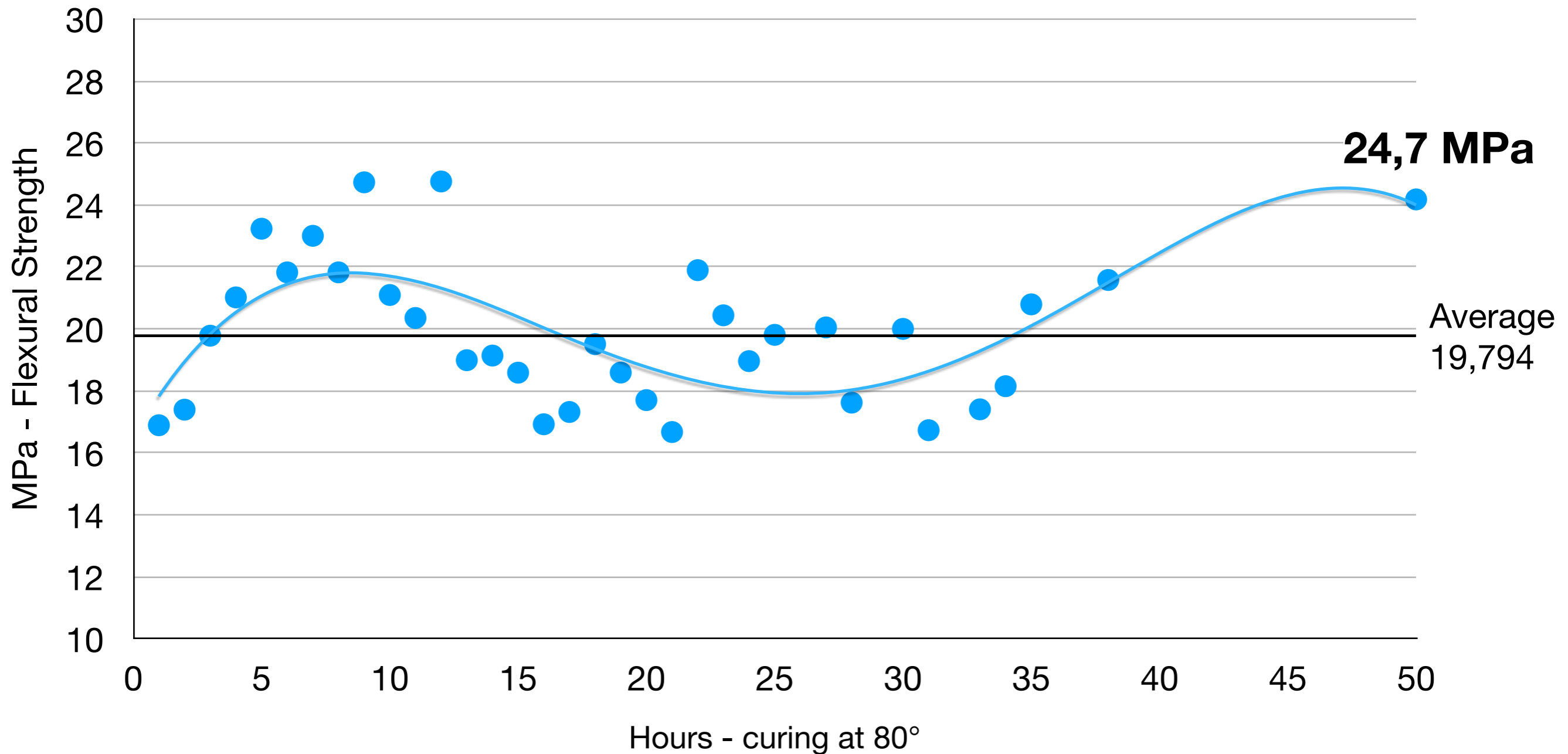
Finding the optimum

M88 - K silicate



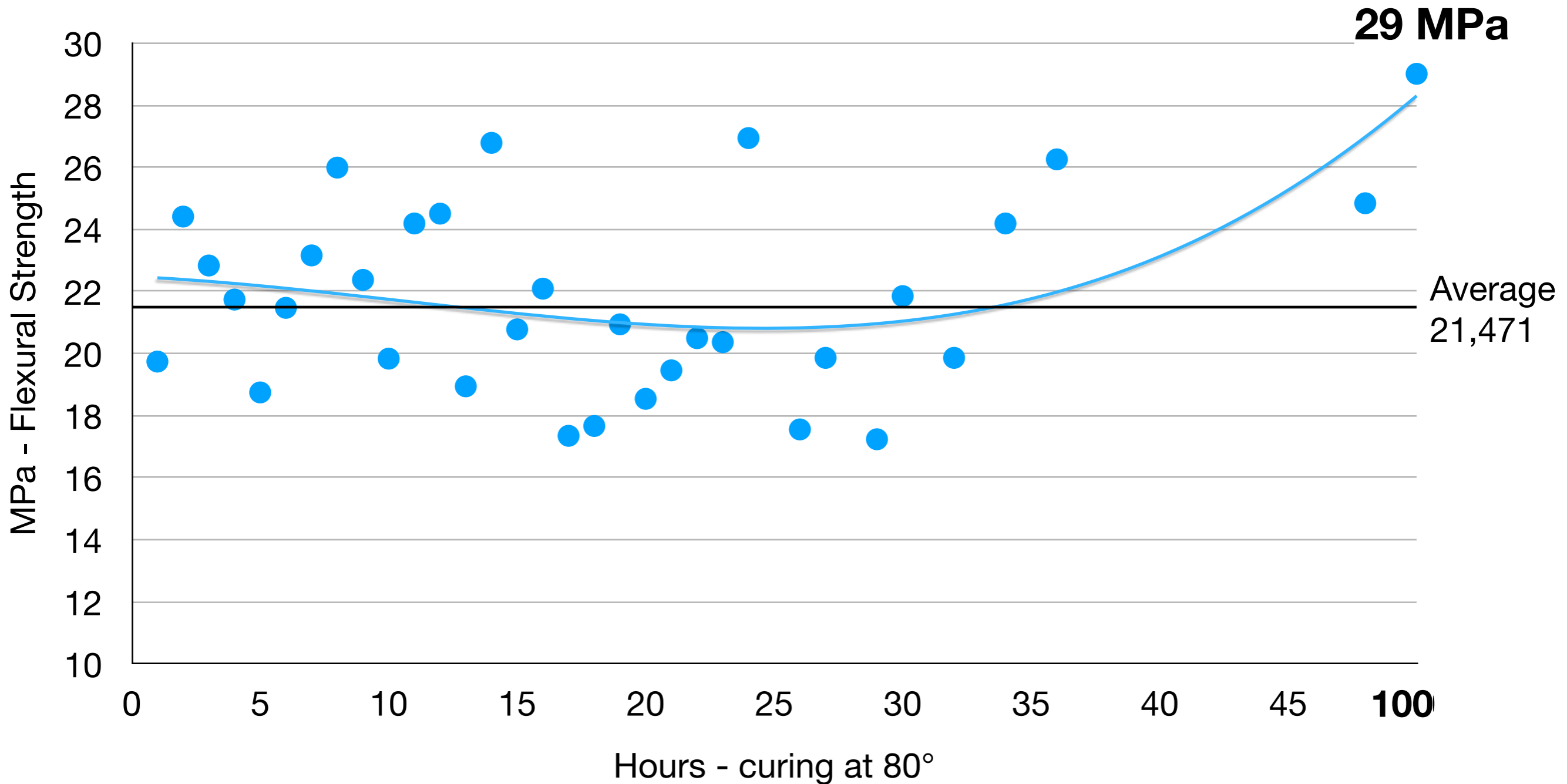
Finding the optimum

C90f - K silicate



Finding the optimum

M92 - K silicate

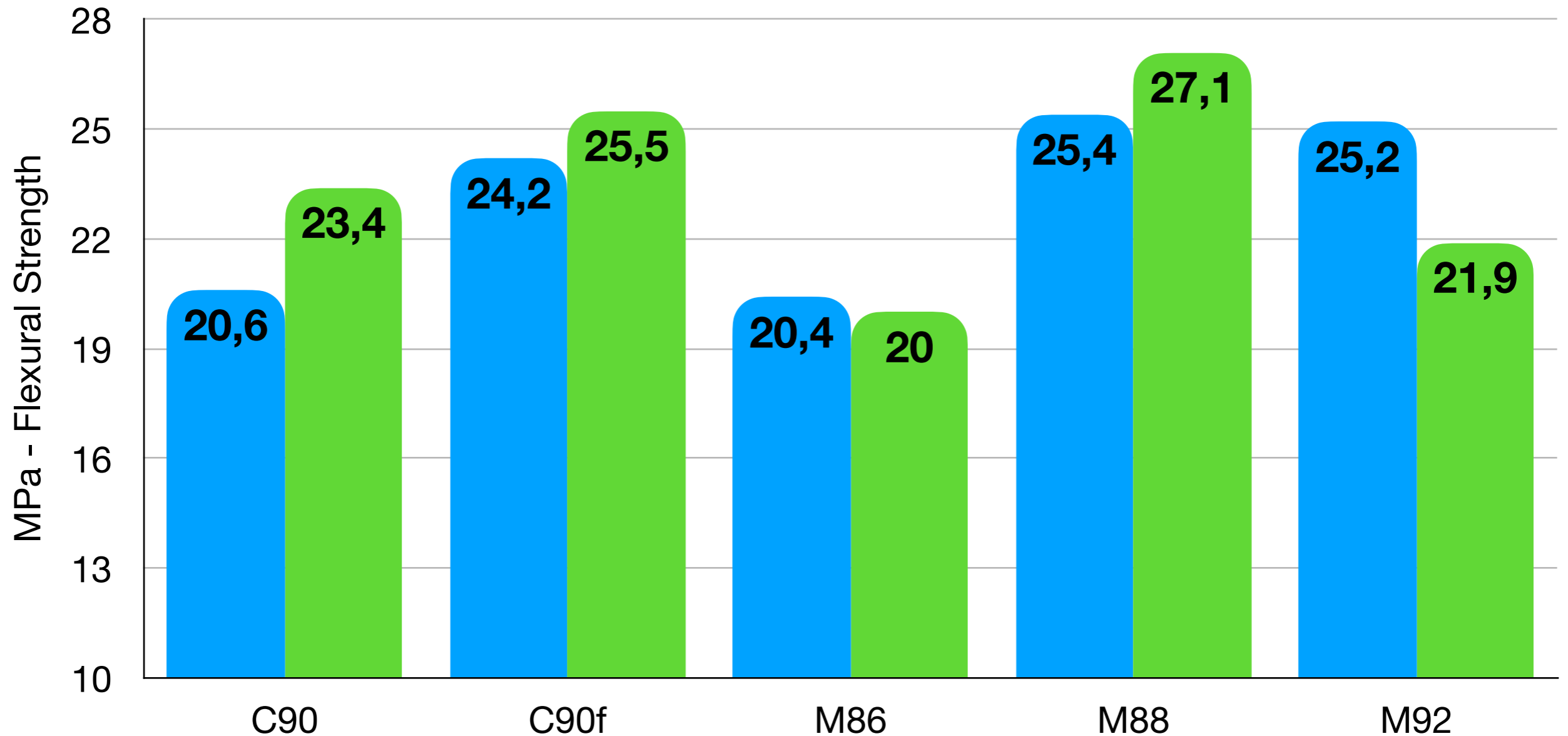


Finding the optimum

Flexural Strength

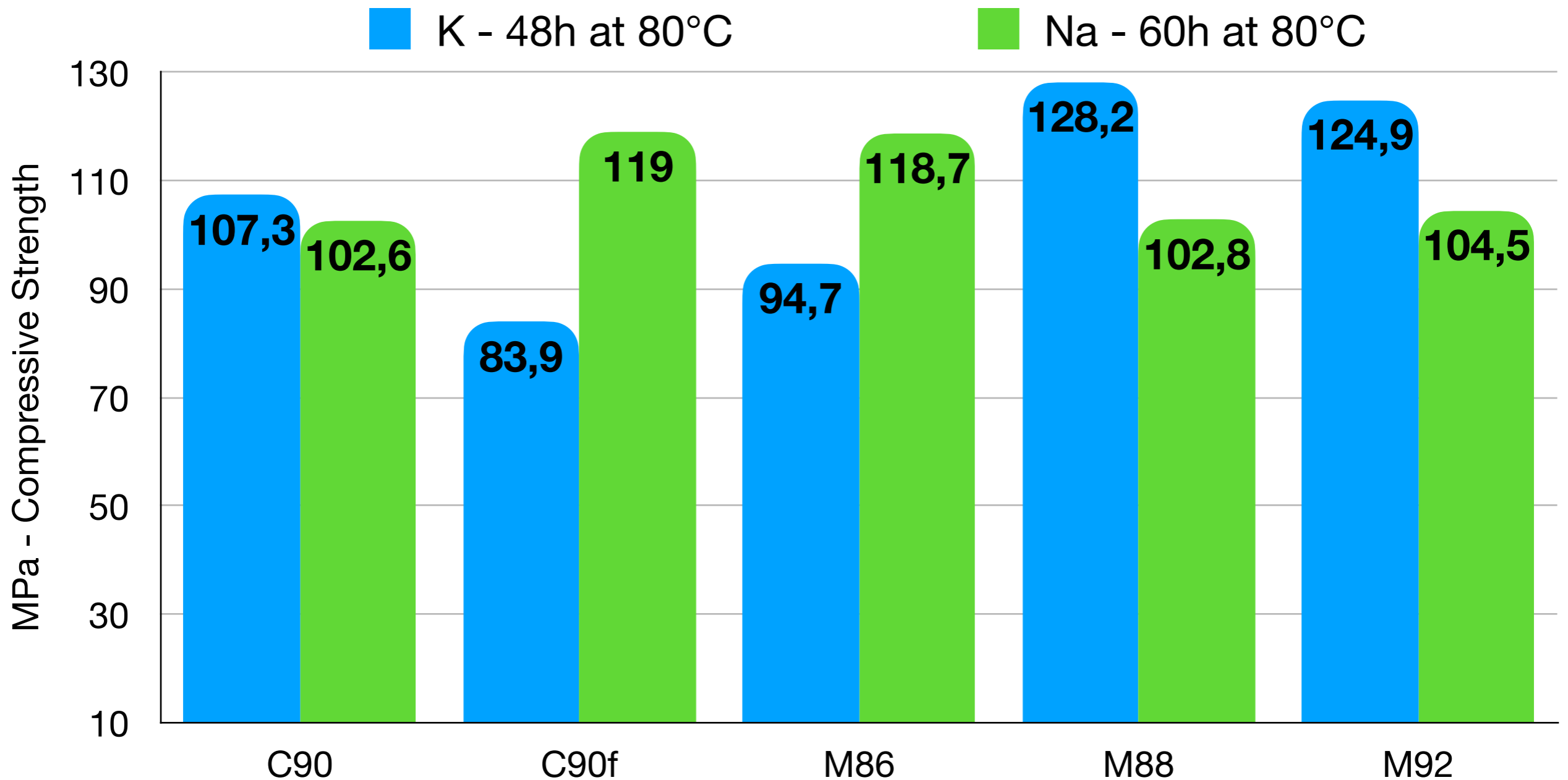
■ K - 48h at 80°C

■ Na - 60h at 80°C



Finding the optimum

Compressive Strength



Second Conclusions

- The mechanical strength could be higher because they all get the same amount of fillers:
Geosil K 14517 + MK + 120 %wt Cristobalite (d50 100µm)
Geosil Na 34417 + MK + 80 %wt Cristobalite (d50 100µm)
- **World Record with M92 + Geosil K 14517 + Feldspar (d50 63µm)**
3 ingredients only formula. Cured for 100 hours at 80°C
30 MPa flexural - 190 MPa compressive
Ceramic is about 40 MPa flexural strength
Scientific literature: 10 MPa flex, 70 MPa compressive
- More studies has to be carried out to clearly understand the reasons
- TemPozz Metakaolins are raising a new standard for geopolymers both in strength and price. More aggregates means less binder for the same volume. About 30% cost reduction.



TemPozz Metakaolins are distributed in Europe by Xatico.

Carine Lefèvre : carine.lefevre@xatico.com