19.08.2015
St. Petersburg

Comparison and Development of the Self Levelling Underlayment Systems Using Hemihydrates, Calcium Aluminate Cement and Portland Cement

Agenda

- Company Information
- Who is Çimsa ?
- Çimsa with Numbers
- Research and Application Center Facilities
- Calcium Aluminate Cements in SLU
- Scope of The Project
- Blends
- Blend Results
- Conclusion

Company Information

SABANCI …A Leading Industrial & Financial Conglomerate

Core Business Units

- Banking
- Industry
- Retail & Insurance
- Cement
- Energy
- Others

- 26 Group Companies
- 11 JV`s
- 58.907 Employees (2013)
- USD 12,7 Billion Consolidated Revenue (2013)

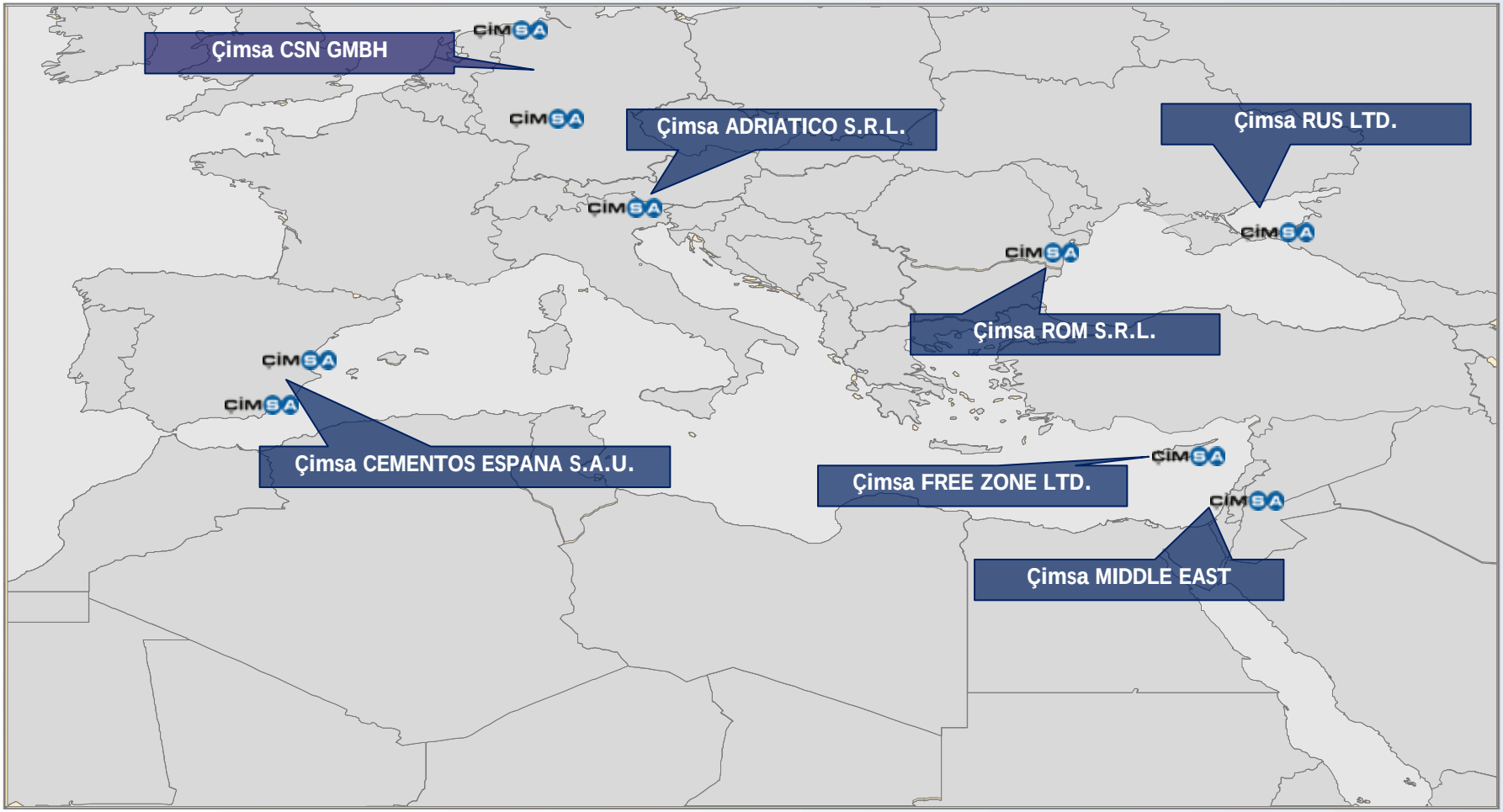
Who is Çimsa?

- Set up in 1972 and started cement production in 1977.
- Has 5 cement plants, 27 ready mixed concrete facilities and 8 terminals (Germany, 2 in Spain, Italy, Romania, Russia and Middle East).
- In the first 3 brands in white cement worldwide.
- Has capability to produce white, gray and calcium aluminate cements (6 Mts of gray, 1.2 Mts of white clinker capacity)

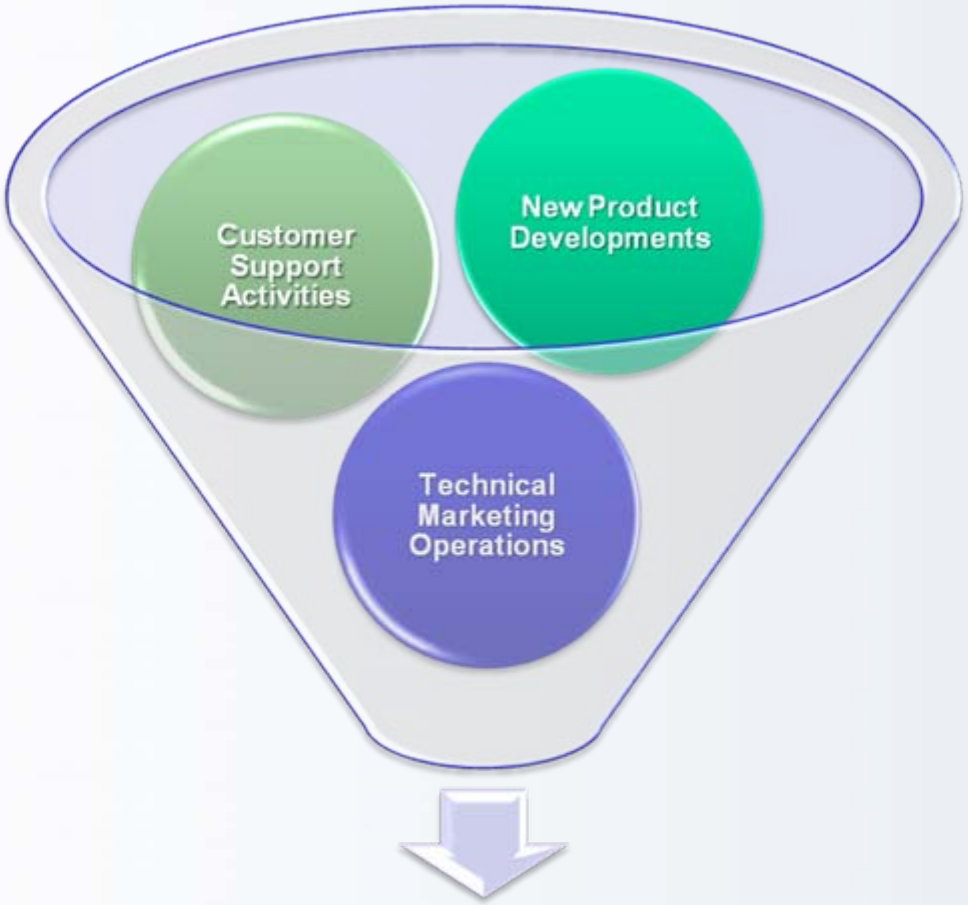
Çimsa with Numbers

- 1977 → Started Operating in Mersin / Turkey
- 1989 → First Cement Production Facility Producing Both White and Gray Cement
- 1999 → White Cement Production Facility Started Operating
- 2002 → Started to Produce Calcium Aluminate Cement
- 1990 - 2004 → New Plant Investments
- 2000 - 2011→ 8 International and 2 Domestic Terminals

International Terminals



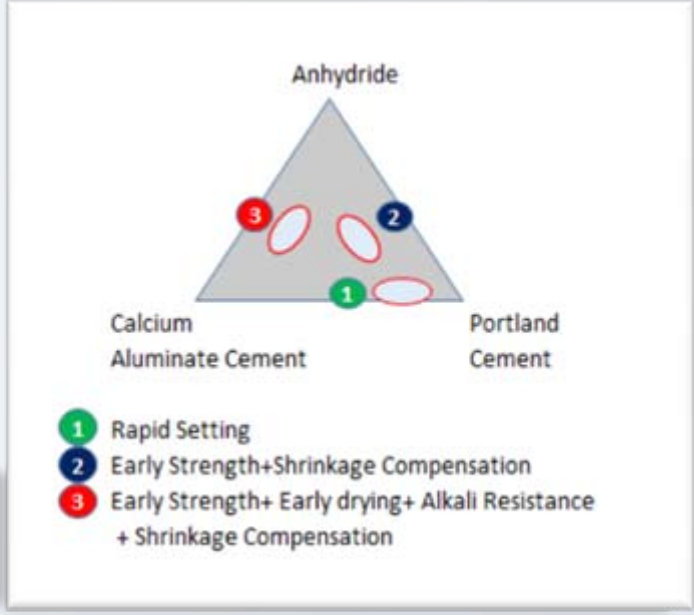
Research and Application Center Facilities



Why Calcium Aluminate Cement in SLU

Calcium Aluminate Cement (CAC) differs from ordinary portland cement with these properties;

- High Early Strength Gain,
- High Temperature and Thermal Resistance,
- Acid Resistance,
- Superior Durability In Biogenic Corrosion,
- Abrasion Resistance



Scope of The Experiment

- The aim of this work is to investigate the performance of different blends for self levelling systems by using portland cement, calcium aluminate cement (CAC with %40 and %35 alumina content) and gypsum.
- The performances are measured in terms of;
  - Strength,
  - Shrinkage resistance,
  - Setting time,
  - Water demand

Self Levelling Underlayment

- 6 different blends are prepared with self levelling properties. These are;
  - CAC 40 + Portland Cement
    - **a. PC Dominant - PC40**
    - **b. CAC 40 Dominant – 40PC**
  - CAC 35 + Portland Cement
    - **c. PC Dominant - PC35**
    - **d. CAC 35 Dominant – 35PC**
  - Portland Cement + Gypsum
    - **e. Alfa Hemihydrate – APC**
    - **f. Beta Hemihydrate - BPC**

Blends

The mixture design for the PC dominant recipies;

Material	Amount %
Portland Cement	28
CAC 40 or CAC 35	12
Fly Ash	7
Citric Acid	0,2
Li_2CO_3	0,05
Antifoam	0,2
Powder Plasticizer	0,2
Silica Sand	67
Plasticizer	0,5
Polymer	0,1
Sodium Oleat	0,2
Water	17

Blends

The mixture design for the CAC 35 & CAC 40 dominant recipies;

Material	Amount %
Portland Cement	5
CAC 40 or CAC 35	15
Calcite	25,95
Citric Acid	0,2
Li_2CO_3	0,2
Antifoam	0,2
Stabilizer	0,05
Silica Sand	30
Plasticizer	0,2
Polymer	1
Sodium Oleat	0,2
Water	26,5

Blends

The mixture design for hemihydrate dominant recipies;

Material	Amount %
Portland Cement	8,3
Alfa Hemihydrate	22
Calcite	20
Citric Acid	0,05
Silica Fume	1
Antifoam	0,1
Stabilizer	0,05
Silica Sand	47,1
Hyper Plasticizer	0,9
Polymer	0,05
Powder Plasticizer	0,5
Water	11,5

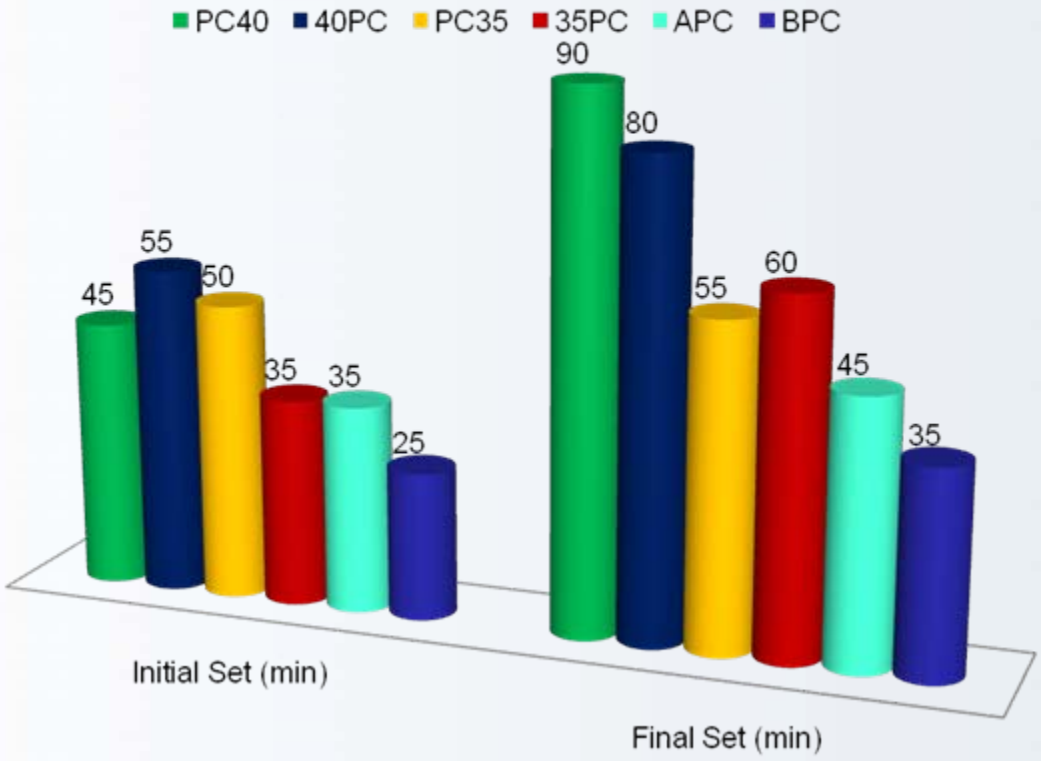
Material	Amount %
Portland Cement	8,4
Beta Hemihydrate	22,1
Calcite	20,1
Citric Acid	0,05
Silica Fume	1,1
Antifoam	0,1
Stabilizer	0,05
Silica Sand	47,2
Hyper Plasticizer	0,9
Polymer	0,05
Water	11,5

Blends

To control the workability of the system; the setting time, disperse diameter and water demand are determined;

Mix	Initial Set (min)	Final Set (min)	Disperse Diameter (cm)	Water Demand (%)
PC40	45	90	29	25
40PC	55	80	15	15
PC35	50	55	29	25
35PC	35	60	21	15
APC	35	45	21	12
BPC	25	35	17	12

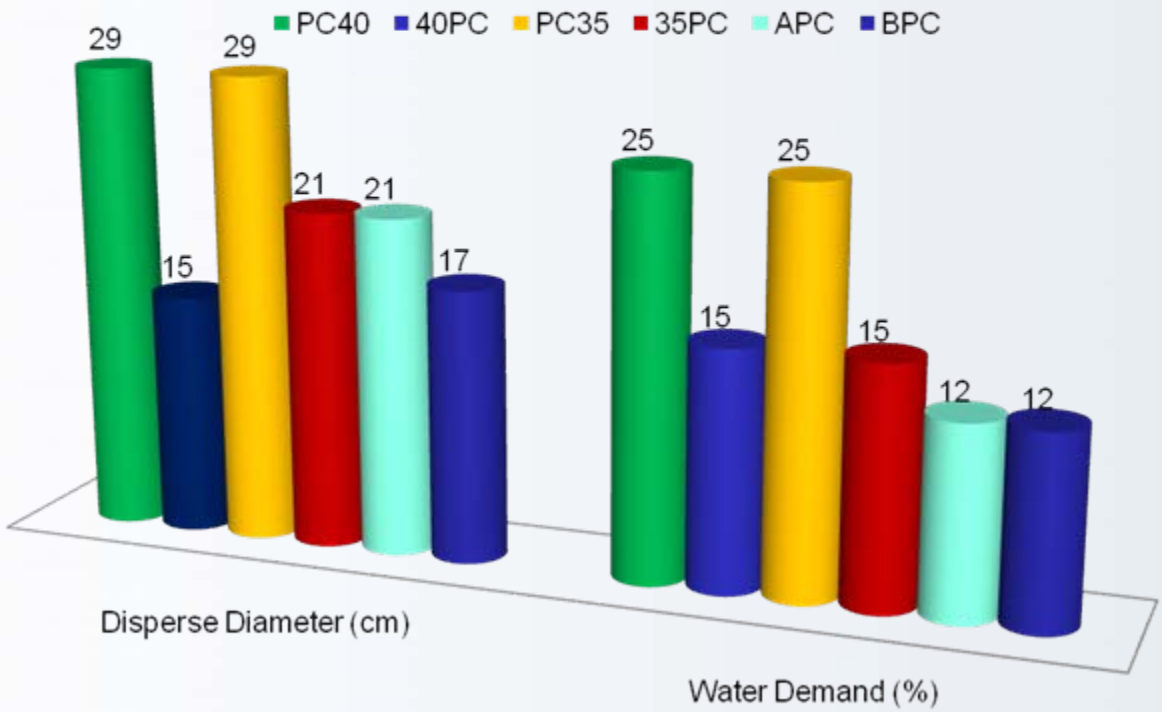
Blend Results - Setting Time



- The setting time values are acceptable but the beta hemihydrate with PC (BPC) blend gives a little time to work on a mortar or underlayment so the final set should be adopted to a more workable level using more chemical additives.

- Also, the PC40 blend has a slightly long final set time which can cause loss of time while working.

Blend Results - Disperse Diameter / Water Demand



- The disperse diameters of self levelling underlayment are measured with conic apparatus, the systems can be excepted as self levelling but 40PC sample has more water demand in order to satisfy dispersing abilities.

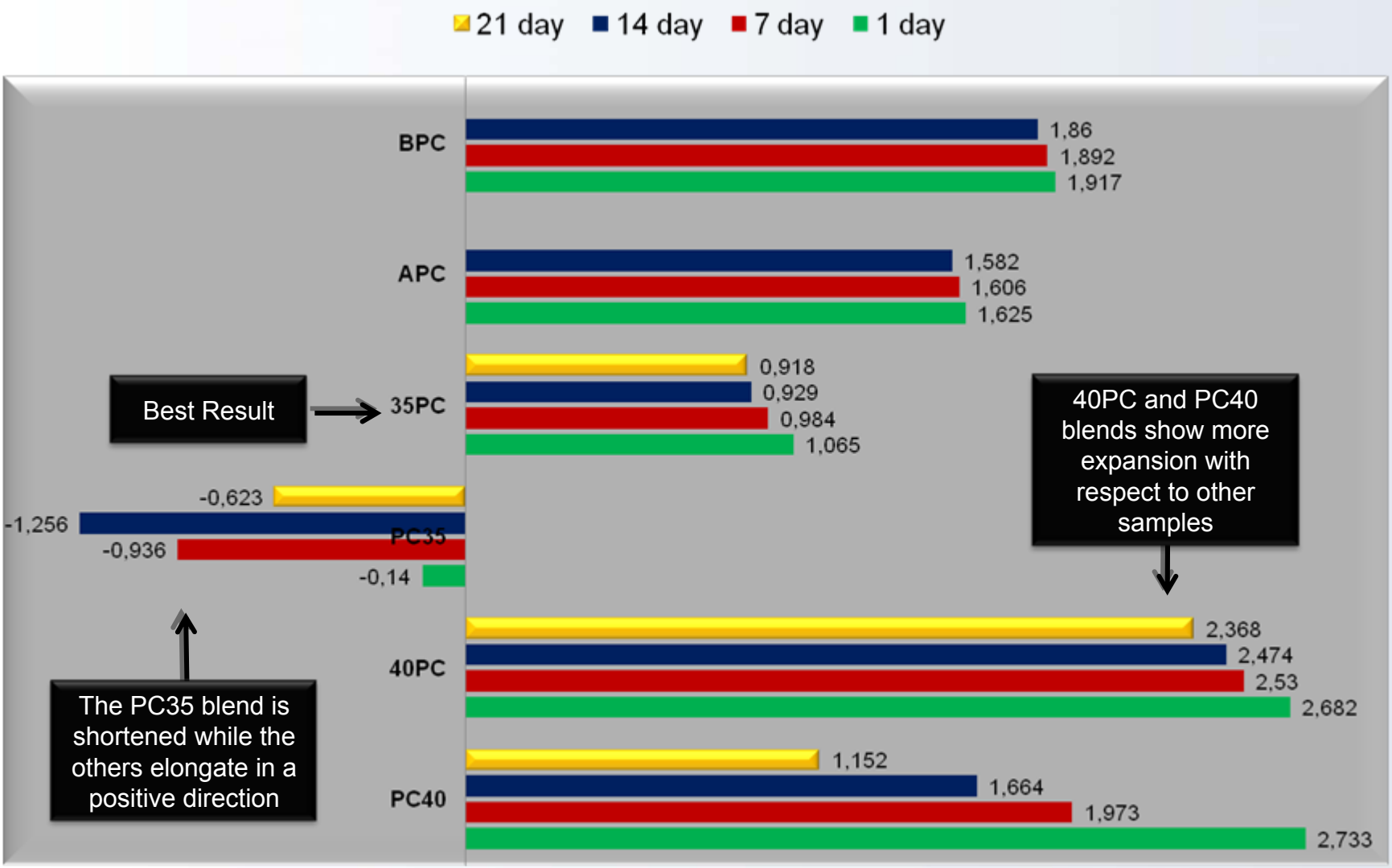
- PC40 and PC35 propagate easier than other blends but the water demand is high which can lead shrinkage problems in time.

Blends

In order to estimate the shrinkage behavior of the underlayment; the elongation values are determined using bending measuring unit;

Mix	1 day	7 day	14 day	21 day
PC40	2,733	1,973	1,664	1,152
40PC	2,682	2,530	2,474	2,368
PC35	-0,140	-0,936	-1,256	-0,623
35PC	1,065	0,984	0,929	0,918
APC	1,625	1,606	1,582	1,520
BPC	1,917	1,892	1,860	1,840

Blend Results - Elongation of the Samples

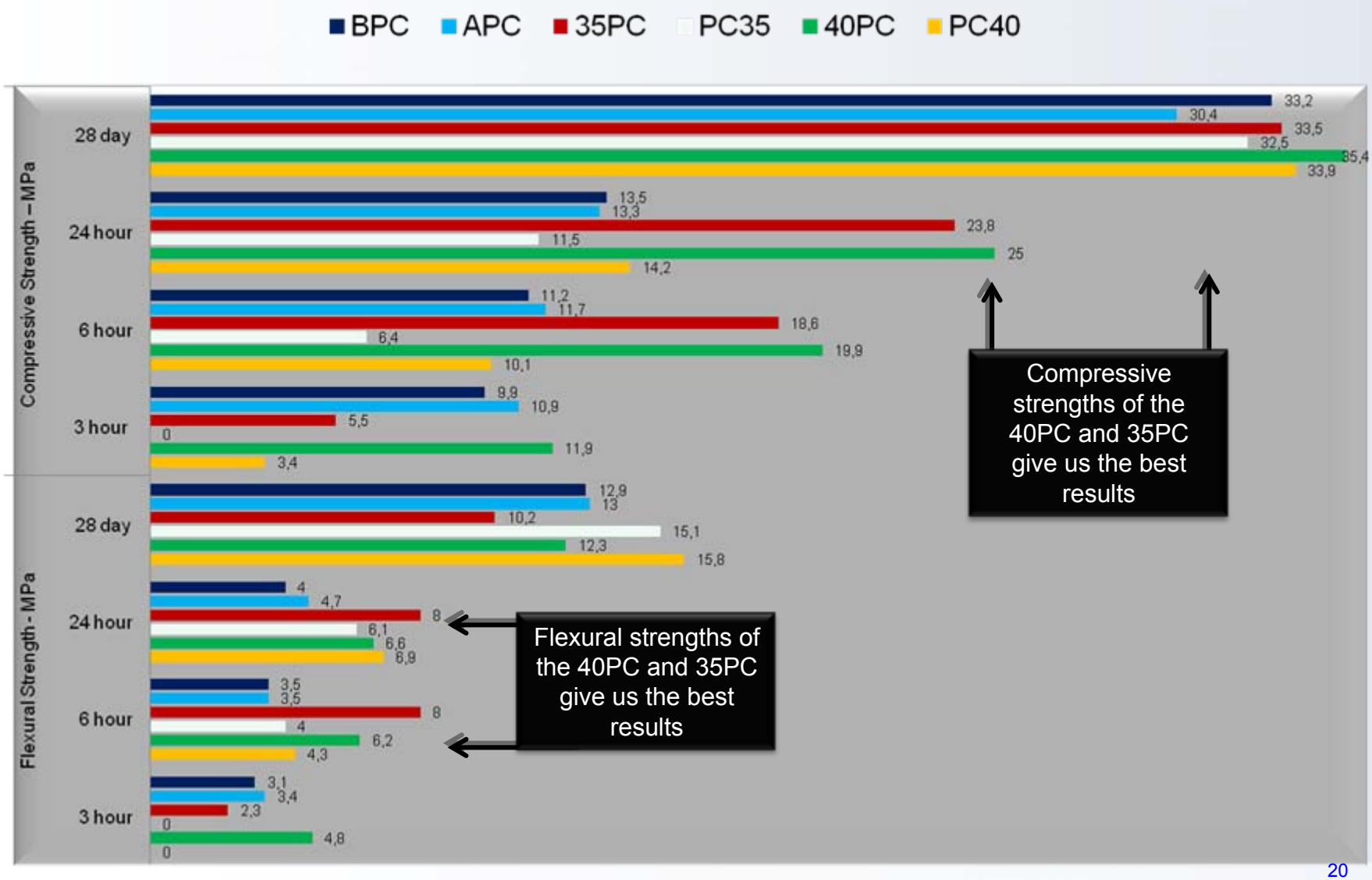


Blends

To estimate the durability of six different SLU systems the flexural and compressive strengths are determined;

Mix	Flexural Strength - MPa				Compressive Strength – MPa			
	3 hour	6 hour	24 hour	28 day	3 hour	6 hour	24 hour	28 day
PC40	0	4,3	6,9	15,8	3,4	10,1	14,2	33,9
40PC	4,8	6,2	6,6	12,3	11,9	19,9	25	35,4
PC35	0	4	6,1	15,1	0	6,4	11,5	32,5
35PC	2,3	8	8	10,2	5,5	18,6	23,8	33,5
APC	3,4	3,5	4,7	13	10,9	11,7	13,3	30,4
BPC	3,1	3,5	4,0	12,9	9,9	11,2	13,5	33,2

Blend Results - Strenght



Conclusions

- To estimate the durability and performance of 6 different SLU systems, the flexural and compressive strengths are determined. The shrinkage compensation is measured with respect to elongation, setting time and dispersion diameters;
  - Shrinkage compansation for the alfa hemihydrate is slightly better than other gypsum system.
  - Long term strength performances of CAC dominated CAC + PC system gives the best results.
  - CAC40 dominated SLU system has accurate setting time for workability.
  - **All in all, CAC35 dominant system (35PC) shows the best performance with respect to compressive strength, dispersion, setting time and shrinkage.**

THANK YOU FOR YOUR ATTENTION

For Further Information :

Cement Research and Application Center

Toroslar Mah. Tekke Cad.

33013 Yenitaşkent - Mersin TÜRKİYE

T : +90 324 241 23 37

C : +90 505 939 64 98

F : +90 324 454 00 52

e-mail : m.sucu@cimsa.com.tr

t.delibas@cimsa.com.tr

SABANCI