Liquid additive trial

by Ciro Rizzi, Brendan Corcoran, Mapei Cement Additives Division, Italy

This article is based on an industrial trial report on the production of CEM IV/B-P 32.5 R cement at the Colacem cement plant in Sesto Campano, Italy using the Mapei grinding additive MA.P.E./W 1111. The objective of the trial was to produce an industrial evaluation of the grinding additive MA.P.E./W 1111, a liquid product for the production of Pozzolanic cements specifically formulated with raw materials of the highest quality.

Sesto Campano plant where the trials have been held

Characteristics of the grinding circuit

The grinding circuit is particularly interesting in that it consists of two mills and a mixer.

Pozzolana is dried and ground in a Löesche LM24 vertical mill and is then stored in an intermediate silo.

Clinker and gypsum are ground in a Fema tubular ball mill, ø3.8 x 13.75m in a closed circuit consisting of a third generation Humboldt separator, ø3.5 m with four cyclones. The gases exiting from the mill are filtered by means of a bag filter. Grinding additive is added to the first chamber of the ball mill.

A mixer receives and homogenises the cement (clinker and gypsum) coming from the ball mill and the pozzolana coming from the intermediate silo, thus producing the finished CEM IV/B-P 32.5 R cement.

The power absorption of the principle machines are as follows:

Löesche vertical mill:	465kW
Fema tubular ball mill:	1.990kW
Humboldt separator:	98kW

MA.P.E./W 1111 is an additive with a triple action, developed to increase the workability and mechanical strengths of the ground cement as well as ensuring high mill productivity.

The trial consisted of grinding a CEM IV/B-P 32.5 R cement at the same level of fineness, with and without the addition of MA.P.E./W 1111, verifying immediately the effects on mill productivity and successively on workability, mechanical strengths and separation performance.

Figure 2a: results of industrial trial

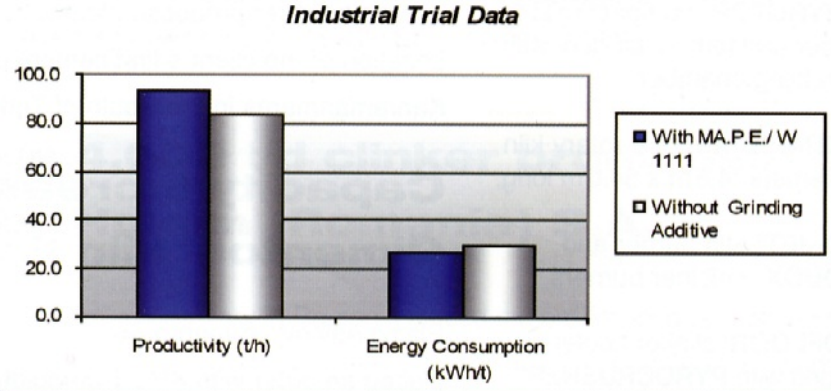


Figure 1: layout of the grinding system at the Sesto Campano plant, Italy

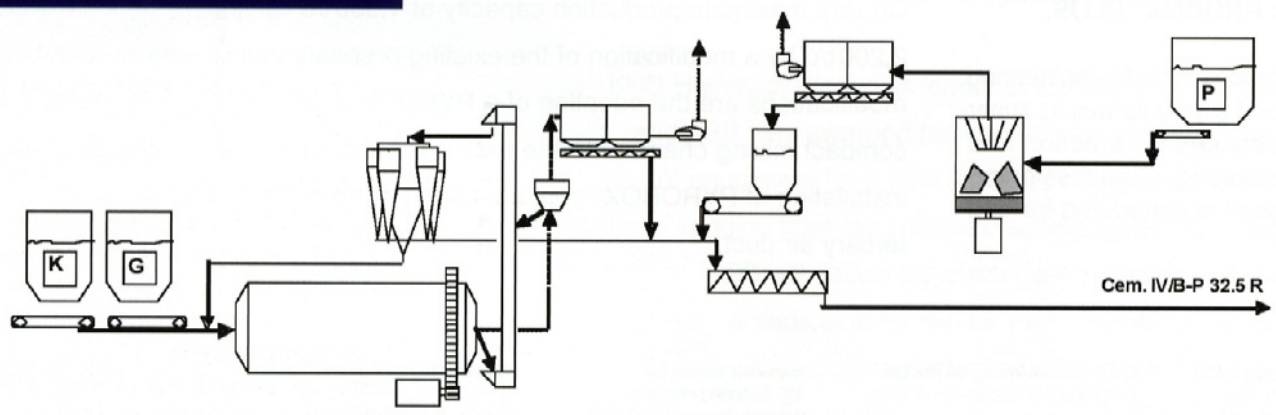


Table A: trial results

Details	*Units*	*Blank*	*MA.P.E./W 1111*
Cement	Type	CEM IV/B-P 32.5 R	CEM IV/B-P 32. 5R
Additive dosage	g/t	–	2.700
Production	tph	83.9	93.8
Passing material at 40µm	%	80	81.5
Passing material at 63µm	%	94	95
Specific mill and separator Consumption	kWh/t	30.4	27.2
Workability	Flow	36	48
Strengths at 24 hours	MPa	8.0	10.6
Strengths at 2 days	MPa	16.3	18.5
Strengths at 28 days	MPa	34.9	40.3

Table B: separation analysis

Details	*Units*	*Blank*	*MA.P.E./W 1111*
Cement	Type	CEM IV/A 32.5 R	CEM IV/A 32. 5 R
Additive dosage	g/t	–	2.700
Circulating load	A/F	4.1	3.0
Soutirage (by-pass)	%	41.5	18.8
Diameter of separation	µm	45	37
Inclination of the 2° branch of the curve	°	56	56
Efficiency evaluation		Good	Good
Angle RRB line	°	45.2	45.7
Characteristic diameter (res. 36.8%)	µm	29.4	28.4

Figure 2b: results of industrial trial

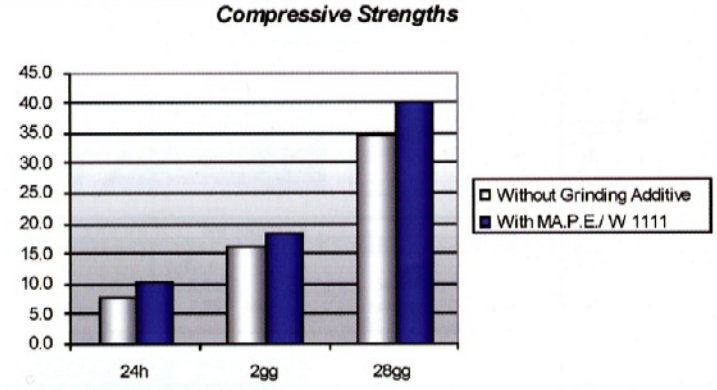
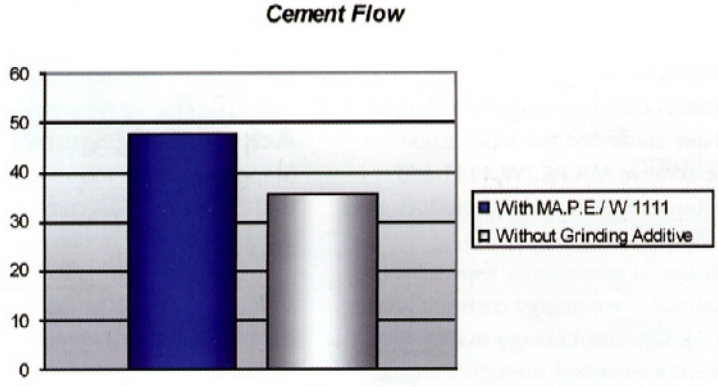


Figure 2c: results of industrial trial



Results analysis

Production

On examination of Table A, it is possible to see that the addition of MA.P.E./ W 1111 has produced an increase in productivity of 11.8 per cent with relevant energy savings. This confirms the product's valid grinding aid characteristics.

Strengths

Strength testing was conducted in accordance with the European standard EN 196-1.

The utilisation of the additive increases the strengths of the cement as follows: + 32.5 per cent at 24 hours, + 13.5 per cent at two days and + 15.5 per cent at 28 days.

Workability

The utilisation of the additive increases the workability by 12 points equivalent to 33.3 per cent.

Separation analysis

During the industrial trial samples of the following materials were taken:

Figure 3: tromp curve according to Mayer – cement ground without an additive

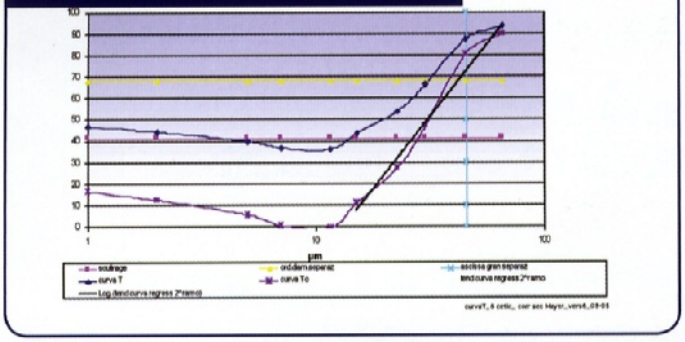


Figure 4: tromp curve according to Mayer – cement ground with MA.P.E/W 1111

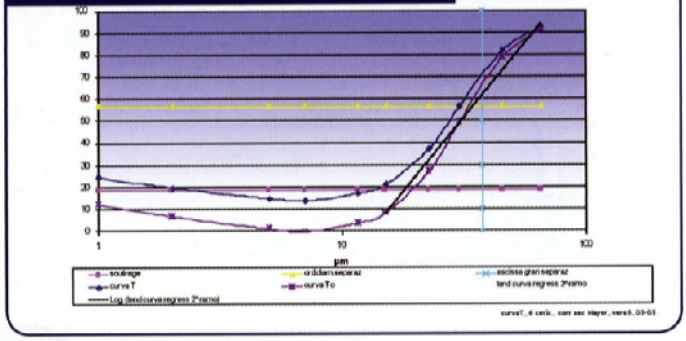


Figure 5b: equation of the regression curve – cement ground without an additive

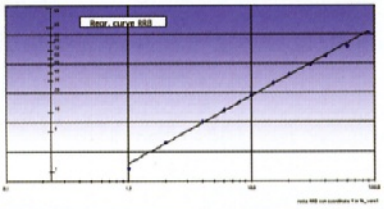
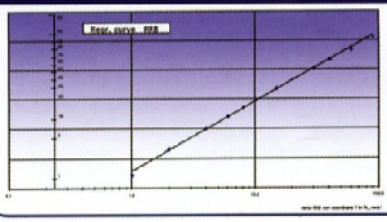


Figure 6b: equation of the regression curve – cement ground with MA.P.E/W 1111 at 0.27



Company	COLACEM S.p.A	Product	Pozzolanic cement
Plant	Sesto Campano	Type	IV/B-P 32.5 R
Mill	Fema 3,8x13,75 m; Loesche Ø 2,4m.		Spec. surf.: m2/k
Separator	Humboldt Ø 3,5 m.		blaine 419,7
Description	Cement ground without an additive		laser 296,7

References
Materials analisys: 140/2005
Sample: C990
Cem. IV/B-P 32.5 R al silo

Laser analysis		
1	2	3
dim µm	res %	pass. %
1,0	97,2	2,8
2,0	93,4	6,6
4,0	87,0	13,0
6,0	81,1	18,9
8,0	75,7	24,3
10,0	70,8	29,2
15,0	59,4	40,6
20,0	49,8	50,2
30,0	37,7	62,3
40,0	26,9	73,1
60,0	16,0	84,0
90,0	5,6	94,4
100,0	2,7	97,3

µm	30	40	60	90	200
Residue (%)	26,5	20,0	6,0	1,0	-

Regression line Y = a + n x					
Uniformity coeff.	n	1,0075	Line coordinates		
cross	a	-3,4078	X(µm)	Y(% R)	100-R
Line angle	Gr	45,2	1	96,7	3,3
Charact. diam.	Xo µm	29,4	29	36,8	63,2
(Residue. 36,8%)			90	4,6	95,4

Figure 5a: equation of the regression curve – cement ground without an additive

Company	COLACEM S.p.A.	Product	Pozzolanic cement
Plant	Sesto Campano	Type	IV/B-P 32.5 R
Mill	Fema 3,8x13,75 m; Loesche Ø 2,4m.		Spec. surf.: m2/k
Separator	Humboldt Ø 3,5 m.		blaine 419,7
Description	MA.P.E./W 1111 at 0,27 %		laser 296,7

References
Materials analisys: 141/2005
Sample: C980
Cem. IV/B-P 32.5 R al silo

Laser analysis		
1	2	3
dim µm	res %	pass. %
1,0	97,2	2,8
2,0	93,3	6,7
4,0	87,0	13,0
6,0	81,1	18,9
8,0	75,5	24,5
10,0	70,4	29,6
15,0	58,5	41,5
20,0	48,5	51,5
30,0	35,3	64,7
40,0	24,0	76,0
60,0	13,5	86,5
90,0	4,6	95,4
100,0	2,5	97,5

µm	30	40	60	90	200
Residue (%)	25,0	18,5	5,0	1,0	-

Regression line Y = a + n x					
Uniformity coeff.	n	1,0240	Coordinate per tracciare la retta RR		
cross	a	-3,4257	X(µm)	Y(% R)	100-R
Line angle	Gr	45,7	1	96,8	3,2
Charact. diam.	Xo µm	28,4	28	36,8	63,2
(Residue. 36,8%)			90	3,8	96,2

Figure 6a: equation of the regression curve – cement ground with MA.P.E/W 1111 at 0.27

- separator feed
- separator finished product
- recycle from separator
- finished cement.

The samples were subjected to laser and Alpine granulometric particle distribution analysis.

In Table B the results of the separator yield, the Tromp curve and the RRB regression line equation are reported.

The results indicate the separator's (third generation) good level of separation efficiency in both conditions of operation.

It is interesting to observe how the utilisation of the additive leads to a significant reduction of the circulating load from 4.1 to 3.0. Mill grinding has improved and the cement particles are less agglomerated. In addition, there is a substantial reduction in the quantity of the material which by-pass the separator without being classified, passing from 41.5 per cent without an additive (blank) to 18.8 per cent with the additive.

As regards the investigations conducted on the cement, tracing the RRB regression line we do not find substantial differences except a minimal increase in the slope of the line and a minimal reduction of the particle distribution curve when the additive is utilised.

Conclusions

The results obtained from the industrial trial have confirmed the triple action of the additive MA.P.E./W 1111 and continuous utilisation of this product gives the following benefits:

- increases in productivity, especially in the periods when energy costs are lower ensuring significant energy savings
- cement mechanical strength increases
- an increase in the workability of the cement. The inferior water demand reduces the consumption of cement and helps the synergy with plasticiser additives employed in the production of concrete.

Acknowledgements

Mapei would like to express its gratitude to the Colacem SpA company for granting the authorisation to conduct the trial.

A special note of gratitude to the staff of the Sesto Campano plant for the collaboration and much appreciated assistance extended.