INVESTIGATION THE POSSIBILITY OF POZZOLANIC CEMENT CEM IV 42,5N PRODUCTION IN CEMENT PLANT KAKANJ

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ABSTRACT

This paper presents an experimental study to evaluate the possibility of CEM IV 42,5N producing by increasing the specific cement surface from 3180 to 3850 cm^2/g. In this paper, fly ash is used as a cement admixture because fly ash possesses both hydraulic and pozzolanic properties. If one part of the clinker, as a major cement admixture, is replaced with a certain amount of fly ash, the pre-existing deposit of fly ash is reduced, which can eventually give cheaper cement. Also, using more fly ash would reduce the emmision of CO2 into the atmosphere. Of course, in order to produce such pozzolanic cement, the requirements of EN 197-1 must be satisfied. Test results show that by increasing the specific surface of cement, the compressive strength of cement which meets the requirements for 42.5N class cement is also increased.

1. INTRODUCTION

The worldwide aspiration of cement producers is to reduce CO_2 emissions into the atmosphere. By reducing the clinker content and using fly ash in cement production, it creates the possibility of reducing CO_2 emissions during production. If the content of clinker in cement is reduced, the amount of natural resources required for clinker production will also be reduced, and thus the ecological preservation will be positively affected. Also, using more fly ash to produce cement opens up the possibility of producing cheaper cement because fly ash is a much cheaper material than clinker.

Pozzolanic cement is obtained by grinding Portland cement clinker, gypsum and pozzolan whose content varies from 11-55%. According to EN 197-1, pozzolanic cements belong to the fourth group of cements (CEM IV) and there are two classes of pozzolanic cement, which are [1]:

- CEM IV / A containing 11-35% of pozzolan or fly ash,
- CEM IV / B containing 36-55% of pozzolan or fly ash.

The constituents discussed in this paper are:

- clinker produced in the Kakanj cementplant,
- fly ash of Kakanj thermal power plant.

2. EXPERIMETAL

2.1. Materials and method

Clinker is produced by the sintering process of a precisely specified mixture of raw meal. Clinker is a hydraulic material that is largely composed of four major minerals that give it some reactivity, namely alit (C_3S), belite (C_2S), tricalcium aluminate (C_3A) and tetracalcium alumoferite (C_4AF).

Fly ash is a silica-alumina material capable of reacting with $Ca(OH)_2$ at room temperature and thereby forming compounds having cementic properties. Fly ash consists of fine, spherical particles with a fineness similar to that of cement. With these granulometric properties, fly ash is capable to reduce the standard cement consistency and improving the workability of the cement composite. Depending on the type of coal, fly ash has different chemical composition and different properties.
Bituminous coal ash and anthracite fly ash is pozzolanic (EN 197-1 Type V, ASTM Class F), while fly ash generated by the combustion of sub-bituminous coal and lignite is both pozzolanic and hydraulic due to its high CaO content (EN 197-1, Type W, ASTM Class C). Both types of fly ash contain significant amounts of the amorphous phase. Each type of fly ash can have particles of different morphology, different particle size distribution, and glassy phase. There are other forms of fly ash separation based on carbon content, reactivity or solubility of SiO_2 or pozzolanic activity. The fly ash mentioned in this paper belongs to the group of calcium fly ash (class W) according to EN 197-1 [2].

2.2. Test results

The chemical analysis of clinker and fly ash is given in Table 1, while the mineralogical composition is determined by diffractometer and is given in Table 2. In order for technogenic industrial waste to be used for cement production, it must meet certain requirements according to European standard EN 197- 1 (Table 3) [1].

Table 1. Chemical composition of clinker and fly ash

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Kloridi
	%	%	%	%	%	%	%	%	%
Clinker	20,46	6,19	3,06	65,81	1,62	1,28	0,11	0,61	0,008
Fly ash	45,32	19,34	10,7	16,59	2,45	1,12	0,35	1,43	0,018

Table 2. Mineralogical composition of clinker and fly ash

	Clinker	Fly ash
Alite (C_3S)	63,0	1,24
Belite (C_2S)	14,47	8,67
C_3A	10,67	
C_4AF	9,75	
Sl.CaO	0,98	1,00
Periclas (MgO)	0,14	
Quartz (SiO_2)	0,05	
Arcanite (K_2SO_4)	1,62	
Portlandit (($Ca(OH)_2$)		1,97

Anyhdrite ($CaSO_4$)		1,43
Mullite ($Al_6Si_2O_{13}$)		1,34
Calcite		0,73
Hematite (Fe_2O_3)		1,05
Magnetite (Fe_3O_4)		0,90
Amorphous phase		75,25

Table 3. Requirements for constituents according to EN 197-1 [1]

	Requirements EN 197-1	Clinker	Fly ash
Reactive CaO	>10,0 mas. %		14,65
Reactive SiO_2	>25,0 mas. %		40,05
Wet sieving	10<x<30 mas.%		28,0
Activity index	≥75 %		87,52
Expansion	≤ 10 mm		1,00
CaO+MgO+SiO_2	≥66,6 mas. %	87,89	
CaO/SiO_2	>2,0	3,22	
MgO	<5,0 mas.%	1,62	
Loss on ignition	<9,0 mas.%		0,01

The aim of the work was to prepare the existing CEM IV/B - W 32,5N existing pozzolanic cement, which is currently being produced in the Kakanj cement plant, to be prepared on a higher specific surface area in order to be able to satisfy the requirements for CEM II/B - W 42,5N. Also, the composition of the constituents remained the same (55% clinker, 41% fly ash, 4% gypsum). Table 43 gives the physical-mechanical properties for CEM IV/B - W 32.5N and CEM IV/B - W 42.5N cements. The specific gravity of the samples is 2.98 g / cm^3. Also, in the same table are given the physical-mechanical properties for CEM II/B - W 42,5N produced in the Kakanj cement plant.

Table 4. Physical-mechanical properties of cements

	R 009 (%)	Specific surface (cm^2/g)	Stand.konz. (%)	Setting time		Strength (Mpa)									
				Initial (min.)	Fianl (min.)	Tensile (MPa, days)					Compressve (MPa, days)				
						1	2	3	7	28	1	2	3	7	28
CEM IV/B-W 42,5N	0,2	3850	27,0	215	275	2,3	3,6	4,3	6,1	8,2	10,6	21,1	27,5	35,8	48,0
CEM IV/B-W 32,5N	1,5	3180	26,2	260	310	1,2	2,0	2,5	3,9	6,6	5,0	9,5	13,9	21,4	39,4
CEM II/B-W 42,5N	1,5	3080	26,6	230	275	1,9	2,9	3,9	5,8	8,0	8,3	17,6	21,5	29,0	51,9

3. DISCUSION

Test results have shown that material treated as industrial waste can be a useful material for the production of CEM IV / B - W 42,5N cement. Chemical analysis of fly ash (Table 3.) shows that according to EN 197-1, fly ash of the Kakanj thermal power plant belongs to calcium fly ash because its content of reactive CaO more than 10 wt. % (14.65) and reactive SiO_2 content greater than 25% (40,05). The specific ash surface is 2130 cm^2/g and the specific mass is 2,70 g / cm^3. The loss of ignition of ash is 0.01, which is within the limits prescribed by EN 197-1 (max. 9% by weight). A high content of the amorphous phase in the ash is desirable because the amorphous phase contains reactive alumina-silicates, which makes the ash a very valuable pozzolanic material, while the crystalline phases are poorly reactive at normal temperatures. In fly ash, the content of the amorphous phase in this work is 75,25%. Also, the clinker produced in the Kakanj cement plant satisfied all the requirements of EN 197-1 (Table 3).

4. CONCLUSIONS

Increasing the specific surface area of cement can considerably contribute to improving the physical and mechanical properties of cement production. As fly ash satisfied all the requirements of EN 197-1, it can be stated with certainty that with increasing the fineness of CEM IV/B - W 32,5N cement, a compressive strength is obtained which satisfies the requirements for CEM II/B - W 42,5N cement according to standard EN 197-1 at 2 days 21,1 MPa (condition $\geq$ 10,0 MPa) and at 28 days 48,0 MPa (condition $\geq$42,5 MPa). The use of fly ash for the production of CEM IV / B - W 42,5N cement produces a more environmentally friendly cement, since in this case the need to produce more clinker is reduced and thus much less CO_2 and other gases are released into the atmosphere during clinker production. In this case there would be huge financial savings because according to EN 197-1, CEM II/B - W 42,5N can contain as much as 21-35% fly ash and CEM IV/B - W 42,5N can contain as much as 36-55% fly ash, and fly ash as a component is much cheaper than clinker. An additional benefit would be the less use of natural resources, which would greatly affect the natural environment, and on the other hand would increase the consumption of fly ash and reduce the already existing deposition of this material.

5. REFERENCE

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