SPECIAL CONCRETE WITH POLYMERS

Nicolae ANGELESCU [1], Ioana ION[1] , Darius STANCIU[1],

José BARROSO AGUIAR [2], Elena Valentina STOIAN[1], Vasile BRATU[1]

[1]Valahia University of Targoviste, Faculty of Materials Engineering and Mechanics, Str. Aleea Sinaia, No. 13, Targoviste, Romania

[2]Minho University, Guimarães, Portugal

nicolae.angelescu@yahoo.com, elenastoian22@gmail.com

Abstract

The development of polymeric materials offers new perspectives of science and technology due to their outstanding properties. These properties are obtained either due to the effect of dispersion polymers and their polymerization either due to their intervention in structure formation. They were prepared epoxy resin polymer concrete, Portland cement, coarse and fine aggregate and to evaluate the influence of resin dosage on microstructures and density of such structures reinforced concrete mixtures. The paper detailing the raw materials used in experimental works and structural properties of concrete studied.

Keywords: *polymer concrete, density, porosity, epoxy resin*

1 INTRODUCTION

Polymer materials are widely used for many years but recently they are present in almost every branch of civil engineering due to their specific. Since polymer materials improve the technical properties of these systems are often used as additives or components of mixtures. If concrete structures with polymers is possible to change their composition due to, on the one hand, the demands of the market and, on the other hand, the need for development of high mechanical strength.

Polymers in concrete or concrete type composites - polymer drew attention to the trade because these innovative materials have superior mechanical and chemical properties [1]. These composites have jumped on the widespread development of resistance structures, renovation and restoration of concrete structures already in place.

Uncured epoxy resins offer greater fluidity before hardening, and increases the adhesion force between particles with positive consequences on strengthening the mixture.

Reactions of polymers and cement particles in the concrete mix have great influence on the performance quality and have been scrutinized in recent years such as: concrete with vinyl polymers [2] concrete with vinyl chloride [3], polystyrene [4] or phenolic resins [5].
The properties of concrete composites - polymer are influenced by the chemical nature of the polymer type and quantity used.

Tabel 1 The characteristics of the polymer

Technical data and chemistry	Epoxy resin	Hardener
Function	Reducing the water content, strengthens the concrete structure	Contribute to polymerize the resin
Appearance	White liquid	Yellowish liquid
Relative density (20ºC):	1,05 g/cm^3	1.3 g/cm^3
pH, 20ºC:	5	5
Viscosity (20ºC):	< 100 cps	<90
Chloral content:	≤ 0,1 %	≤ 0,1 %
Alkali content	≤ 2 %	≤ 2 %

2 RAW MATERIALS

For the preparation of polymer concrete have been used:
- SIKA epoxy resin range, which combined with hardener and cement concrete forming polymer binder [6]
- Cement CEM I 42.5R,
- Aggregates crushed granite in two varieties: 0-4 mm (Sort I) and 4-8 mm (Sort II).

2.1. Polymers

It used epoxy resin and hardener in the composition SikaFlor81 era. Technical data for this polymer are shown in Table 1 [6].
The polymers are designed to improve both the workability and strength of concrete mixes with polymers. Epoxy resins have two roles within compositions:

- by polymerization of influencing their structure, using its elastic connection points between the constituent materials,
- forms a thin layer on the cement particles, negatively charged them and produces a repulsion between them.

By participating directly in the formation of the mechanical strengths of their influence.

2.2 The cement

The cement used was the type CEM I 42.5R, Blaine specific surface area equal to 380 m2 / kg and specific gravity of 3.12 kg / m3 [7]. Oxidic composition thereof is shown in table 2.

2.3 The aggregate

In terms of physical properties, borders are hard rocks, compact, with fine grain size and / or coarse metamorphic or volcanic origin, with the following characteristics:

- hardness: 6 to 7 on the Mohs scale,
- Density: 2.6 - 2.8 Kg / cm³
- compressive strength: 140-210 N / mm²,
- modulus of rupture: 15-25 N / mm²,
- water absorption: 0.1-0.6%
- relatively low porosity,
- resistant to weather.

Table 2 The composition -oxide of (CEM I 42.5 R)

Oxide composition, %	
Type of oxid	The cement CEM I 42,5R
SiO_2	19.30
Al_2O_3	5.57
Fe_2O_3	3.46
CaO	63.56
MgO	0.86
Na_2O	0.13
K_2O	0.80
SO_3	2.91
Cl	0.013
TiO_2	-
L.O.I.	2.78

In terms of chemical composition, borders are igneous rocks composed of quartz, feldspar and minerals such as ferromagnesian Kriol, chlorite, garnet etc. A typical granite will have the following chemical composition:

- Quartz (SiO2): 70-75%
- aluminum oxide (Al2O3): 10-15%
- Calcium oxide (CaO): 0.5%
- Peridot (MgO): 0.5%
- Bauxite (Al2O3.nH2O): 2-4%
- Alkaline: 4-6%
- Peridot (TiO2): less than 0.5%
- Loss on ignition (PC) less than <0.5%.

In figure 1 are presented the grading curve of the aggregates used [8] of the two types of sort mentioned above.

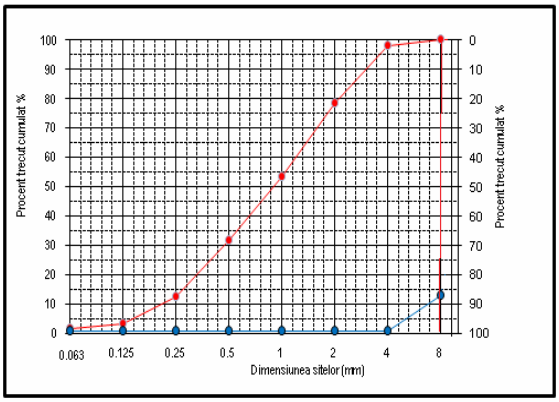

Fig. 1. Analysis of particle size of the aggregate used

2.4 Obtaining the polymer concretes

In this study, three compositions were made of polymer concrete. Epoxy resin content varied between 1 and 10%. Dosages satisfy the workability required.

Polymer concretes with different compositions were prepared by mixing the required amount of binder (cement and epoxy with hardener) the aggregate and water. On hardened concrete we studied the microstructure and were determined their porosity and densities.

3 RESULTS AND DISCUSSIONS

3.1 The density polymer concrete

It analyzed the influence of dosage resin density concrete, which were considered three dosages of resin and experimental data are presented in figure 2.

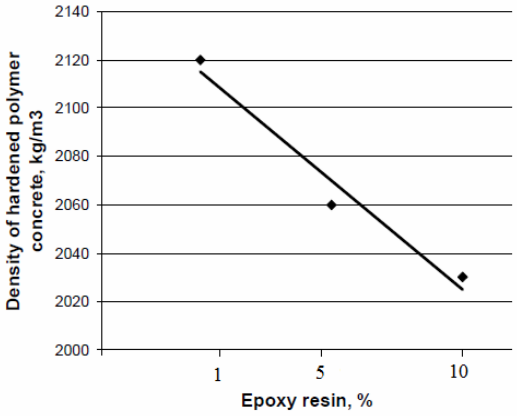

Fig. 2. Hardened concrete density variation depending on the content of resin

The results show that the density of concrete reinforced with polymer decreases the dosage of resin, featuring a linear dependence.

For all analyzed polymer concrete density values have shown that they can be classified as normal concrete with densities (> 2000 kg / m3 and <2600 Kg / m3) [9]

3.2 The microstructure of the polymer concrete

Figure 3 shows the concrete surface obtained only from aggregate, cement and water without polymer additives, where they notice the presence of a large number of goals with a maximum diameter of 0.35 mm.

In the ordinary concrete, it can be seen as byproducts have developed moisturizers and how embedding of aggregate in the mix.
Not can notice neither any formation elastic but just how new hydration byproducts covers both unit and still-hydrated cement particles. These neoformation of hydration continues to develop and evolve over time, as the process evolves hydrating cement particles.

On the other hand, may be noticed in figure 4 an increasing number of goals in the concrete structure of polymers in small proportion (1%), but their diameter shrinks. There had not been bridging linking aggregate value this polymer dosage.

In Figure 5 which shows the microscopic analysis of a concrete with a rate of 5% polymer resin dislocations observed in concrete. It can be concluded that the proportion of value agglomeration process begins polymer resin, which tends to achieve concrete links between constituents.

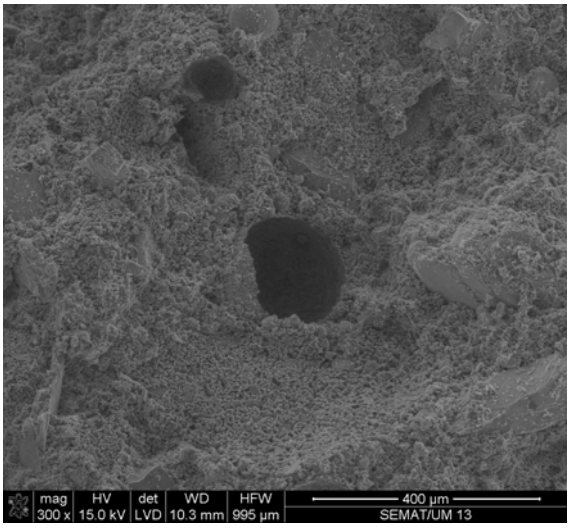

Fig. 3. Microscopic analysis of a concrete normal

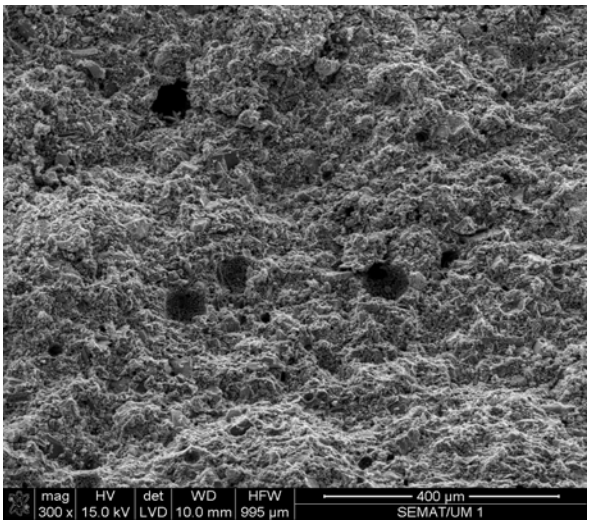

Fig. 4. The microstructure of concrete with 1% resin

In figure 6, it is shown the structure of a concrete containing epoxy resin in a proportion of 10%, where there is clear tendency to form bridges stretch between particles components of concrete, which results in increased strength in compression and tension by bending the structures strengthened .

At the same time congestion can be seen in different places crosslinking of the polymer, and a greater number of such links between particles.

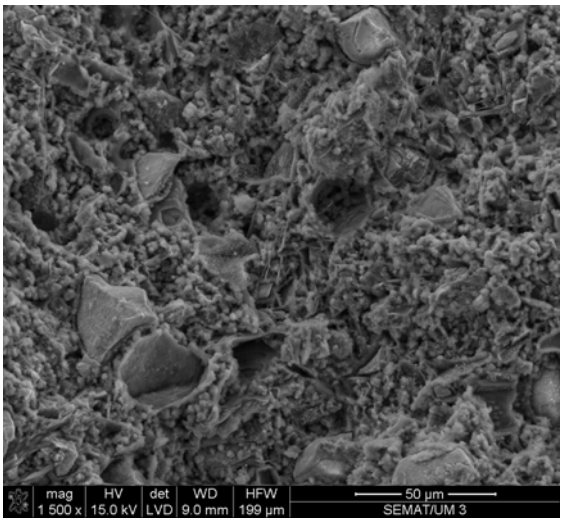

Fig. 5. The microstructure of concrete with an epoxy resin proportion of 5%

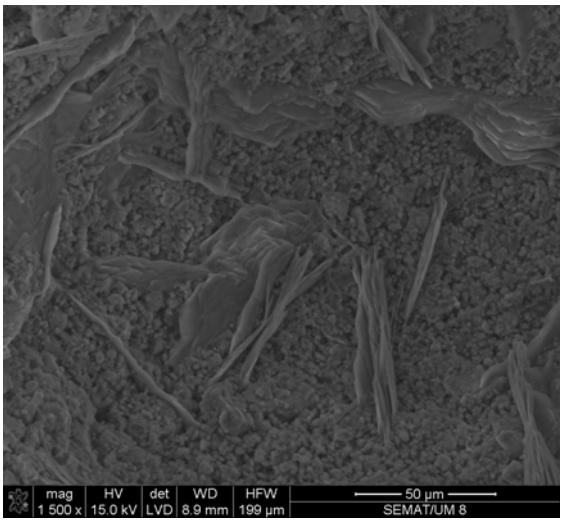

Fig. 6 The microstructure of concrete with an epoxy resin proportion of 10%

It can be concluded that an amount of 10% epoxy resin can reduce the diameters of the holes, you get a denser structure and can also influence the hardening of concrete due to congestion elastic resin that tend to blend aggregates.

3.3 The porosity of concrete polymer

Tabel 3. The porosity of concretes

Type concrete	**The porosity**, %
Concretes usual	7.2
Concrete with epoxy resin 1%	7.2
Concrete with epoxy resin 5%	7
Concrete with epoxy resin 10%	7.1

From table 3 it can be seen that the porosity of concretes containing polymers is close to that of concrete without polymers, but as was noted above volume is higher goals without polymer concrete structure. Polymer concretes tendency exists to fill these gaps with polymer clusters, which have the effect of improving the mechanical properties thereof.

4 CONCLUSIONS

Polymer concrete were obtained by using different dosages of epoxy resin (1-10%), with cement and aggregate.

Microscopic analysis of the resulting polymer concrete structure with the 5% - 10% epoxy resin to form a crosslinked structure of the polymer concrete with the smaller holes.

The density of the concrete cured state with varying proportions of polymer allows for the concrete normal it as a normal volume weight. The resin content increases was a decrease linear density in its cured state.

The porosity of concrete polymer is lower than usual and also number of goals inside the structure is lower, a consequence of the fact that these holes are partly filled by clusters of resin. By using epoxy resin to prepare concrete structures are obtained compact with small holes.

5 REFERENCES

[1] Lech Czarnecki " Concrete polymer composites (C - PC) – Change per continuation", 13th International Congress on Polymers on Concrete, Portugal, 2010.
[2] Sugama T, Kukacka L.E. " The effect Of dicalcium silicate (C_2S) and tricalcium silicate (C_3S) on the thermal stability of vinil type polymer concrete", *Cem . Concr.Res.,vol 9, No 1, p 69-76.*
[3] Larbi J.A., Bijen J.M.J.M. " A study of interface between some polymer dispersionand Portland cement during hydration", *Proc Of VI ICPIC, p.* 185 – 192.
[4] Putterman M., Malorny W, " Some doubts and ideas on the microstructure formation of PCC", *Proc Of IX ICPIC, sept 14-18, p. 165-178.*
[5] Nair, Priya and A. Paul "Microstructure of phenolic resin cement concrete", *Proc Of 25th Conference On Cement Muicroscopy And Symposium On Rietveld Techniques*, ICMA, U.S.A.. 2003.
[6] www.sika.com.
[7] Fisa tehnica Ciment CEM I, 42,5R.
[8] European Standard EN 933 – 1/2000 – Tests for geometrical properties of aggregates.Determination of particle size distribution, Sieving method.
[9] European Standard EN 12390- 7/ 2003 – Testing hardened concrete. Density of hardened concrete.

Acknowledgement

This work was partly financed by the European Social Fund through the POSDRU/CPP107/DMI1.5/S/77497 Program for PhD. Student