

EXPERIMENTAL DETERMINATION OF OPTIMAL DOSAGE ACTIVATOR FOR POZZOLANIC BINDER FORMULATION

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1. Introduction

The use of mixes stabilized with pozzolanas has been internationally established since 1987, during the International Roads Congress held in Brussels, and it is ascertained that pavements with stabilized layers were already widespread in the entire world [1].

In Romania, although the thematic scientific preoccupations have been synchronic to the international ones and have been finalized with the elaboration of instructions and norms to be applied, there has been no resort to current application, due to bureaucracy inertia as well as to professional biases of road constructors, stimulated by some inadvertences of the normative stipulations and by the severity of the imposed technical condition for this technology.

The Romanian regulation CD 127-2002 [2] recommend the use of some aggregate-pozzolana-activator mixes in the following compositional formulae reported to the total weight in dry state:

- aggregate + 20, 25, 30 % blast furnace slag
- aggregate + 10, 20, 30 % fly ash
- aggregate + 6, 8, 10 % pozzolana.

The activator dosage (according to the 74th article of CD 127-2002 [2]) is indifferent unto the kind of pozzolana used:

- 2% lime or cement, if the mix is grouting in fixed stations;
- 3% lime or cement, if the mix is made in situ.

The prescription of dosages by 2% or 3% activator-lime or cement regardless of diversity and quantity of activated pozzolana is scientifically unsubstantiated, because the quantities of activator must strictly correlate with the chemistry of activated pozzolana, so that the dosage of activator must needs related to quantities (dosage) and the type of pozzolana, and not to the performance technology: grouting in fixed stations or made in situ.

2. Test data

Within of the laboratory researches it was followed by experimental way the appraisal of the

optimum dosage of activator – lime, optimum dosage being the percentage of lime related to the pozzolanic mass where for the compressive strength on stiff pastes made of pozzolana-lime couple and water has maximum value.

For practical reasons, during lab researches for establishing the compositional formulae of pozzolanic binders the "step-by-step" strategy as adopted consisting in successive tests of quality and quantity combinations between various materials (pozzolana, activator agent, water) followed by testing of physical and mechanical parameters for validating the optimum variant.

The following compositional variants were tested:

- V1 - Portland cement II-AS 32.5R (as a dummy specimen)
- V2 - fly-ash + lime, various proportions
- V3 - coarse blast furnace slag, commercial sort 0-8 + lime
- V4 - milled volcanic tuff + lime
- V5 - milled granulated slag + lime
- V6 - milled granulated slag + Na(OH)

The pozzolanic material - fly ash, blast furnace slag and pozzolana - were grind at a grinding smoothness characterised by the whole passing through the sieve by 90 μm .

The pozzolana-activator agent mixes in strictly determined proportions were homogenized in the ball mill for 30 minutes. Water was added in order to obtain equal consistency pastes, then cast into metallic molds of 2 x 2 x 2 cm and compacted on shock table, then maintained in the following conditions:

- 48 hours in molds covered with PVC folium at 20...22°C;
- 48 hours after removal of molds, in water at 22...24°C;
- 66 hours in water at 60°C (gradually heated from 24°C in thermostatic bath);
- cooling in atmosphere for 6 hours up to 22°C

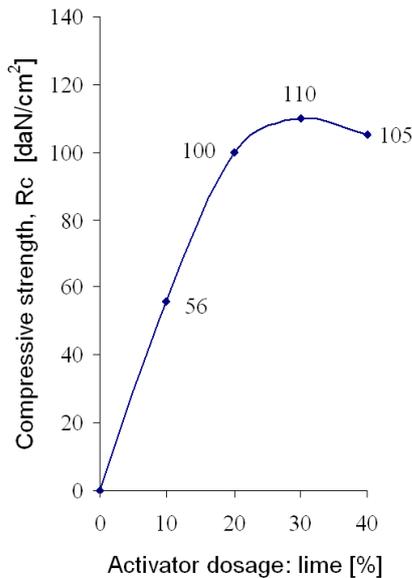


Fig. 1: Binder CvV fly ash + lime CvV30. Optimum binder formulation: fly ash + 30% lime of fly-ash mass

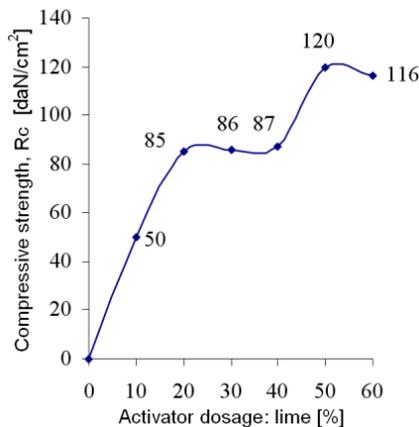


Fig. 2: Binder TvmV grounded volcanic tuff + lime TvmV50. Optimum binder formulation: tuff + 50% lime of tuff mass

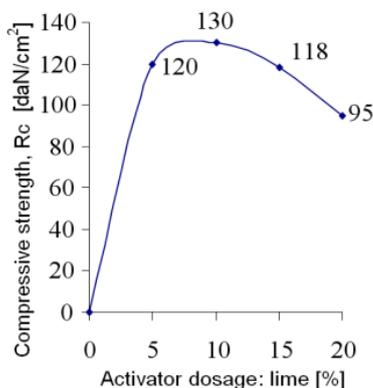


Fig. 3: Binder ZmV granulated ground slag +lime ZmV10. Optimum binder formulation: slag + 10% lime of slag mass

After seven days of maturation in the mentioned above regime the specimens were tested for compressive strength (R_c). The activator agent content corresponding to the maximum compressive strength designates the optimum composition of the investigated pozzolanic binder.

The validated variants are shown in figures 1, 2, 3.

3. Conclusion

The complex thermal analyses (DTA + DTG) make evident the evolution of hydration and hardening processes by formation of CSH phases due to calcium and silica from binder constituents, and of AFM respectively, due to calcium and alumina. During researches, the activator agent with optimal dosage was entirely consumed.

The binders previously established are classified in resistance classes stated in SR EN 196-1 and SR ENV 13282/2002, as follows:

- V2 – fly-ash + 20% lime
- V5 – milled slag + 10% lime
- V4 – milled tuff + 50% lime

The principle of this method was, also, extended to other origin sources of the pozzolanic materials and the experimental results confirming the applicability of the researches undertaken in this study.

The testing of various pozzolana-activator formulas showed a positive correlation between the nature of pozzolana and the proportion (dosage) of activator shows that the stipulation, in accordance with the CD 127-2002, for use a general dosage of 2 or 3%, depending on the technology of preparation of mixtures, is obsolete.

References

- [1] Andrei B., The study of road sub-bases treated with hydraulic derivatives. PhD thesis, Technical University of Civil Engineering of Bucharest, 2006 (in romanian language)
- [2] ***, The normative CD 127-2002 for the construction of the road layers by natural aggregates stabilized with pozzolanic binders, 2002 (in romanian language)