INTEGRATION OF PLASTICS WASTES IN ROAD CONSTRUCTION

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Abstract: The main objective of this study is the recovery of plastics wastes in ground form in road construction. The proportions of plastic additions being 1%, 2%, 3% and 4%. The CBR values of 44; 48; 56; 41,5 and 39 were obtained for raw laterite and mixtures containing 1% respectively; 2%; 3% and 4% of plastics.
This article presents the results of a research study on the use of crushed of plastics wastes mixed with Sindia laterite in road construction materials.
At the end the experimental studies show that treatment with cement (with a mixture of 4 %) would make it possible to improve the geotechnical properties of these materials effectively for base-layer application. It appears from this latest study CBRs of 243; 280; 345; 263 and 241 respectively for raw laterite and laterite containing 1%; 2%; 3% and 4% of plastics wastes.
This work shows that the wastes of plastics can be used in road construction materials.

Keywords - CBR, Cement, Dray Density, Laterite, Plastic, Waste

I. INTRODUCTION

Plastic waste poses major risks to the environment, climate, and public health. Indeed, their wild deposits cause visual and olfactory pollution, but above all a land and sea occupation. Their decomposition releases methane (a powerful greenhouse gas) and toxic elements that contaminate soil and groundwater through infiltration.

Several methods of recovery of plastics wastes are used in the world to mitigate their presence in nature and thus their vulnerabilities. These are generally recycling, chemical and energy recovery. However, these methods remain inefficient since they make it possible to recover 21% of plastics wastes [1].

Thus, we propose to study the influence of the addition of crushed plastics wastes on the mechanical behaviour of laterite used in pavement layers. We study raw laterite and laterite-plastic mixtures at percentages of 1%, 2%, 3% and 4%.

The results show that laterite mix with plastic is just suitable for use as a foundation layer of a road pavement with respect to specifications but requires cement treatment for a base layer application [2].

II. MATERIALS AND METHODS

The plastics used belong to the family of thermoplastics. The latter constitutes an overwhelming majority of plastic waste in nature.
The laterite comes from Sindia, town located at 53 km from Dakar (Senegal).

The materials are subjected to standard tests of identification and mechanical behaviour at the Soil Mechanical [3-6].

III. RESULTS AND DISCUSSION

3.1.Particle size analysis

The size analysis of the laterite soil shows 18% of pebble 50% of gravel, 21% of coarse sand and 3 % of the grains mass pass the 80 µm sieve (Fig.1).
Thus, this laterite has more coarse aggregates which constitute the skeleton of building materials. Consequently, the effects of particle size distribution on the behavior of lateritic soil are important [7].

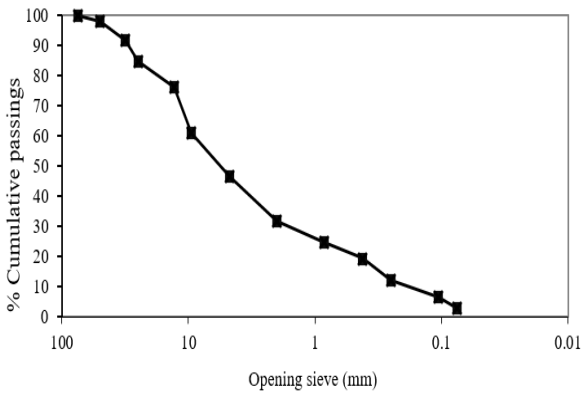

Fig.1. Size analysis of Sindia's laterite

3.2. Modified Proctor Compaction Tests

Based on the percentage of plastic added to the mixture, the modified Proctor test allowed us to obtain the compaction curves shown in Fig. 2a.
The Fig. 2b below provides a clearer illustration of the variations in dry density at the modified Proctor optimum, depending on the proportions of laterite and plastics in the mix.
The sample containing 1% plastic develops a higher dry density ($\Upsilon dmax$ = 2.21 T/m^3) than raw laterite ($\Upsilon dmax$ = 2.15 T/m^3). This slight improvement may be due to the reduction of voids in laterite following the addition of plastic. In fact, the plastic easily

conforms to the shape of the voids contained in the laterite aggregates during the test, helping to tighten the structure.

Beyond this percentage (1%) of addition, the plastic in the mixture reduces the dry density value compared with that of the raw laterite, as can be seen in the Fig. 2b. The reduction in density can be explained on the one hand by the elongated shape of the plastics and on the other by the fact that the plastic, for certain proportions in the mixture, absorbs part of the energy during compaction. This damping of compaction energy affects the densification of the overall structure of the material, reducing it.

However, the various dry densities obtained remain higher than that specified by CEBTP for the use of a material in the pavement body [8-11].

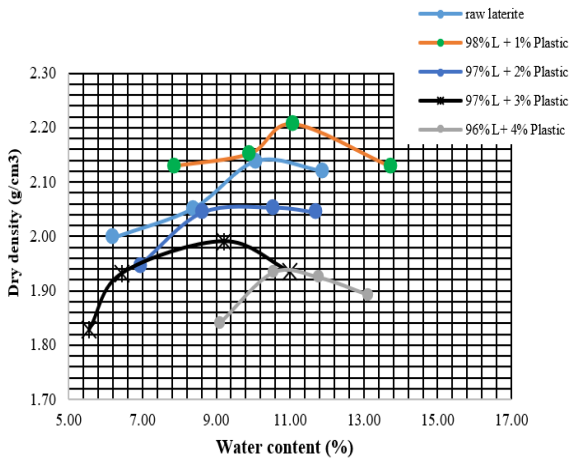

Fig.2a. Compaction parameters as function of plastic content.

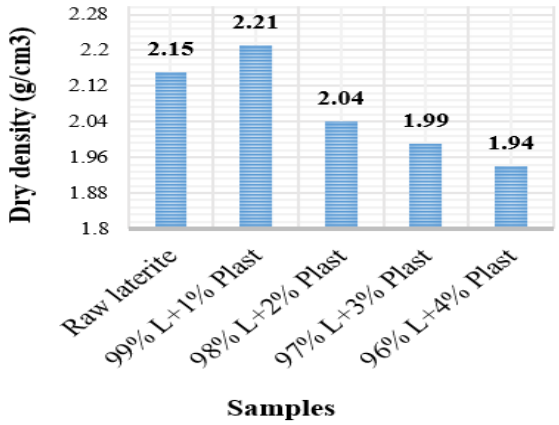

Fig.2b. Compaction parameters as function of plastic content.

3.3. CBR Tests

Depending on the percentage of plastic added to the mix, the following CBR values were obtained after immersion.

Fig. 3 shows that mixes containing 1% and 2% plastics develop a higher CBR index after immersion than raw laterite (CBR = 44). This CBR value increases with the addition of plastic, reaching its maximum at 2% plastic (CBR = 56). These results show a positive behavior of the bearing capacity at pavement level for these plastic additions. This improvement can be explained by the fact that the plastic improves the strength of the mixture, which in turn increases its bearing capacity.

Above 2%, the mixture loses bearing capacity, dropping to 41.5 for the mixture containing 3% plastic and 39 for the mixture containing 4% plastic. This can be explained by the absorption of compaction energy by the plastic, which affects the mix's lift by reducing it.

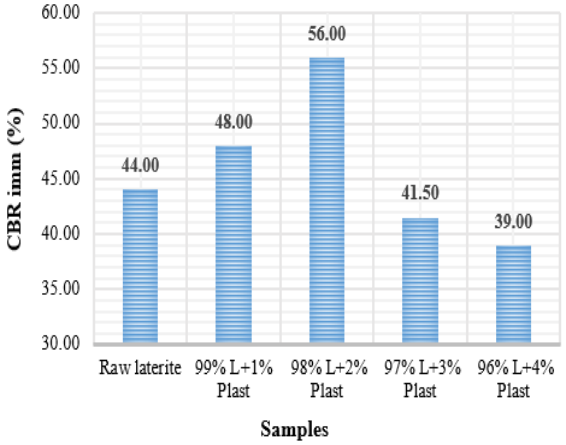

Fig. 3. CBR results after immersion.

3.4. Use of the material as a base course

Analysis of the results shows that the samples in their natural state are deficient in terms of bearing capacity. The bearing capacity values are below the CBR > 80 specification generally required for the use of a raw material in the base course of a moderately trafficked road. For use in base courses, the various samples were treated with 4% cement (Fig. 4a, Fig. 4b and Fig. 5).

The dry density of cement-treated mixtures decreases with the addition of plastic, reaching a value of 1.99 T/m^3 at 4% plastic. This minimum value remains slightly below the CEBTP specification (Ɣd min = 2 T/m^3) for the use of a base course material. However, mixtures containing 1%, 2% and 3% plastic met CEBTP recommendations, as they developed dry densities of 2.06, 2.02 and 2.007 T/m^3 respectively.

The results of the CBR test reveal that the bearing capacity after imbibition evolves practically in an increasing manner as a function of the addition of plastic before dropping at 3% and 4% plastic to reach a minimum CBR of 241. We also observe that the condition generally required for use as a base course (CBR > 160) is achieved for this treatment with 4% cement. Cement tightened the grains and increased the compactness of the material, making it more stable.

The results thus confirm that cement-enhanced samples can be used for pavement base courses. Compared with mixes containing added plastics, samples containing 1%, 2% and 3% plastics are more recommended.

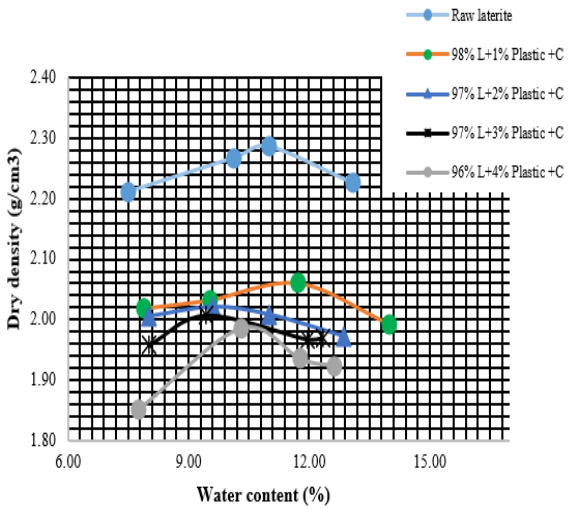

Fig.4a. Compaction parameters as function of plastic and cement content.

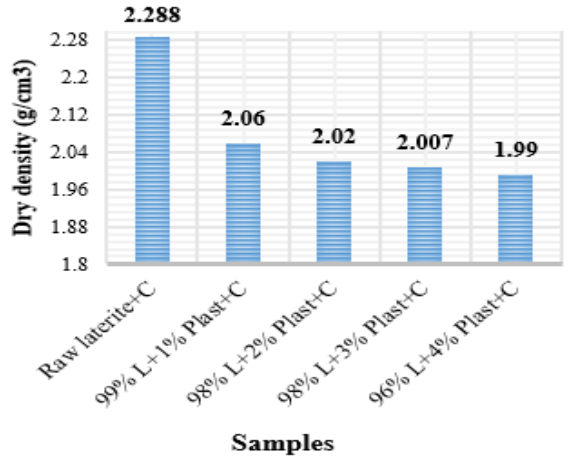

Fig.4b. Compaction parameters as function of plastic and cement content.

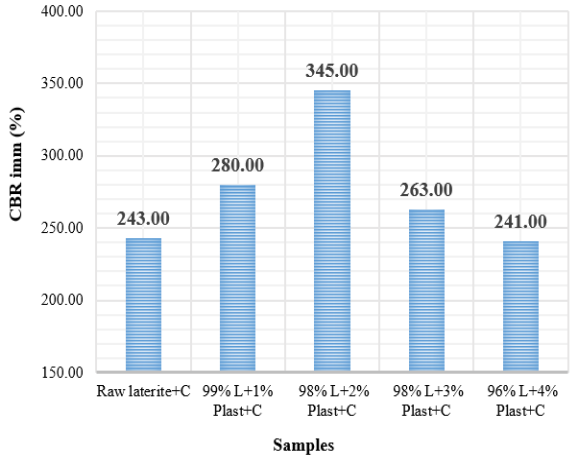

Fig. 5. CBR results after immersion with cement.

IV. CONCLUSION

The tests carried out on the various samples showed an improvement in dry density for the 1% plastic addition and in CBR bearing capacity for the 1% and 2% plastic additions. This was not the case for the 3% and 4% plastic mixes.

For use in road construction materials, the various samples in their natural state can be used as sub-base courses, but their use as base courses does not meet CEBTP requirements.

To meet CEBTP requirements, the samples were treated with 4% cement. Following this treatment, samples containing 1% and 2% plastics will no longer be recommended for use in base courses.

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