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USE OF NON-SELECTED CONSTRUCTION AND DEMOLITION WASTE IN A BITUMINOUS MIXTURE

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INTRODUCTION

Both extraction and processing of natural aggregates (NA) for bituminous mixtures have significant negative impacts, both economic and environmental [1, 2]. To minimize these harmful effects of NA production, it is recommended to replace it, in whole or in part, with other materials, such as Non-Selected Construction and Demolition Waste (NS CDW), seeking a positive contribution to the 3Rs policy: reduce, reuse and recycle.

OBJECTIVES

The main objective of this work is to evaluate the effects of 10% replacement by dry method [3] of NA by NS CDW (Figure 1) in a bituminous mixture for an AC 20 base 50/70 by comparing the Marshall results with the ones attained in a control mixture without any NA replacement.

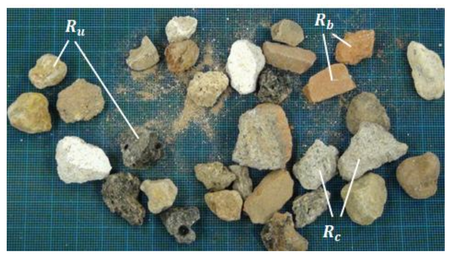

Figure 1 – NS CDW

RESULTS AND DISCUSSION

Several laboratory tests were made to know the main characteristics of aggregates, both NA and NS CDW. Table 1 shows some features about the physical characteristics of either NA and NS CDW aggregates and their requirements according to the Portuguese specifications. The features shown in Table 1 indicate that the NA comply all specifications, but NS CDW exceeds the Water Absorption and the LA coefficient. This may be not a problem as a 10% of NS CDW will be considered and not a total replacement of NA. To characterize NS CDW also the identification of the relative proportions of the constituent materials was done, according to EN 933-11 (Table 2).

Table 1 – Physical characteristics of NA and NS CDW

	Standard	0/4	4/10	10/14	14/20	NS-CDW	CE-EP(2014)
FI	EN 933-3	-	26	15	9	28	30
MB_F	EN 933-9	-	-	-	-	6,7	10
LA	EN 1097-2	-	37	32	-	55	40
ρ_a	EN 1097-6	2,66	2,67	2,67	2,67	2,64	TBD
ρ_{rd}	EN 1097-6	2,65	2,61	2,62	2,63	2,17	TBD
ρ_{ssd}	EN 1097-6	2,65	2,63	2,64	2,64	2,1	TBD
WA_{24}	EN 1097-6	0,1	0,8	0,7	0,6	6,7	2

TBD (to be declared)

Table 2 – NS CDW constituent materials

Constituents	R_c	R_u	R_b	R_a	R_g	R_s	X	FL
%	34	29	25	0,2	0,2	8	3	0,3

The mixtures production with five different bitumen content and the compaction of the specimens were made accordingly to EN 12697-35 and EN 12697-30 respectively. The AC 20 grading limits fulfil the requirements as shown in Figure 2.

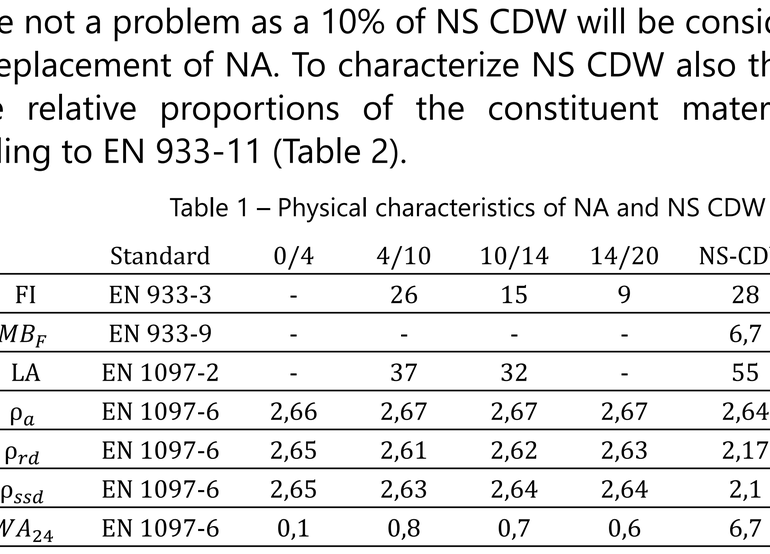

Figure 2 – Grading obtained with 10% NS CDW

The results (Figure 3 f) show that for the control AC 20, the optimal bitumen content is 4,83% while for the AC 20 with 10% of replacement is 5,83%, 1% more than in the control AC 20. Also, there is a slight reduction in Marshall stability which indicates a reduction of the resistance of the bituminous mixture with NS CDW. Differences in flow are less clear for low contents of bitumen in both mixtures and, as expected, the flow is higher for the higher bitumen content in the AC mixture with NS CDW.

The addition of NS CDW has also visible impacts on the volumetrics, in particular air voids, but also density and VMA. As NS CDW has particles of greater porosity than natural aggregate, it is expected that the volume of voids in this mixture will increase with the its addition (Figure 3 c). Increases in bitumen content decrease the volume of voids in both mixtures as these are being filled by bitumen. However, this decrease is lower in the mixture with NS CDW because the bitumen is absorbed, mainly by the adhered mortars in concrete particles (R_c). The volume of voids in the mineral aggregate (VMA) is higher in the mixture with 10 % of NS CDW, also a consequence of the porosity of the NS CDW (Figure 3 d). A note should be done regarding VMA: the Portuguese specifications require a value of 14% VMA as minimum but then AC20 with NS CDW has a minimum value of 20%. Higher porosity of NS CDW decreases density of the specimens (Figure 3 e). Cement mortars and mostly, brick mortars contribute to the lower weight of the specimens containing NS CDW, as they are lighter than the natural aggregate. The maximum density in the mixture with NS CDW is reached with 6% bitumen and the maximum weight in the natural aggregate mixture is reached with 5% bitumen.

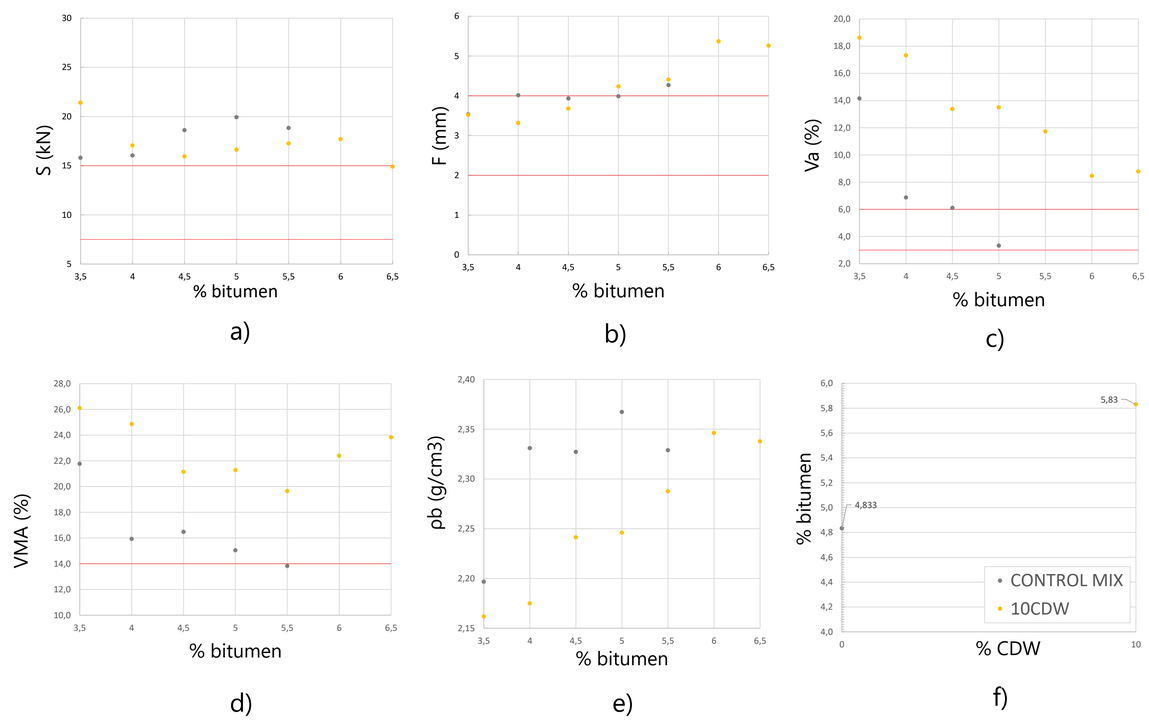

Figure 3 – Marshall properties a) Stability , b) Flow, c) Air voids, d) VMA, e) Density, f) Optimum bitumen content.

CONCLUSION

The replacement of 10% of NA by NS CDW reduces some properties of the asphalt mixture and demands a higher value of bitumen content.

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