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REHABILITATION OF DN 66 SECTOR BUMBESTI JIU – ROVINARI USING COLD RECYCLING IN SITE WITH HYDRAULIC ROAD BINDERS HRB E3

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Abstract: *On the national road sector from DN 66 it was applied a cold recycling in site solution to make the foundation layer by recycling the existing wear layers of road concrete and asphaltic mixtures. Below we are presenting the technology and the results obtained.*

Key words: *cold recycling in site, hydraulic road binders, stabilization, safety in exploitation, optimum technical economical solution.*

1. Introduction

The national road DN 66 it linking the cities Filiasi and Petrosani. This road its connecting Oltenia and Transilvania, crossing the mountains through Jiului Gorges, starting from Rovinari, through Targu Jiu city and it stops on Bumbesti Jiu city. Between Targu Jiu and Bumbesti Jiu the wear layer is made of road concrete BcR 3,5 width between 15 – 22 cm and in some places it has a degraded layer of asphalt (which appeared from maintenance repairs) as you can see in Figureure 1.

Between Rovinari and Targu Jiu the wear layer is made of asphaltic mixture type BA16 very degraded width between 2cm and 15cm, as you can see in Figure 2.

The road superstructure has degradation from fatigue, longitudinal cracks, holes, ruts, tiler cracks, etc. In the same time the road has an improperly bearing capacity.

Fig. 1. *Degraded layers on DN 66 between Targu Jiu - Bumbesti Jiu*

Fig. 2. *Degraded layers on DN 66 between Rovinari and Targu Jiu*

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Starting from the idea to have on optimum solution from technical and economical point of view, which will allow to use the existing resources on the road and in order to obtain the best speed of execution which will offer in the end the necessary bearing capacity, it was chosen the cold recycling in site solution for the existing layers and also to widen the rod on side boxes. The chosen technical solution is presented in Figure 3.

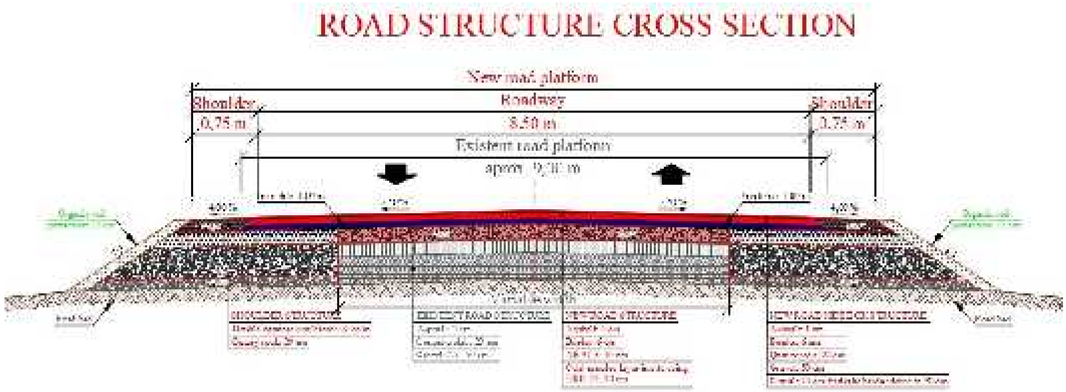


Fig. 3. Typical transversal profile

2. Case studies

2.1. Laboratory Tests Made with Materials Milled in Site

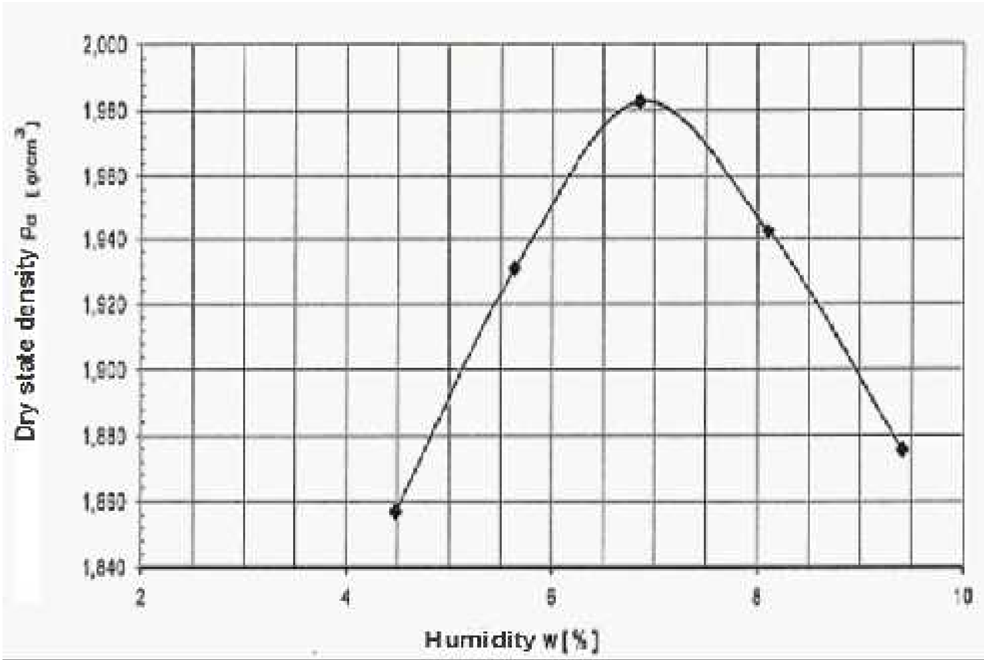
It was taken samples from the milled material both from the asphaltic mixture and from concrete road. These samples were treated with a hydraulic road binder E3 [1] and then were made the specific tests.

In table 1 and Figure 4, are presented the results obtained through Modified Proctor test, and in tables 2 and 3 are presented the results obtained through compression resistance test at 7 days compared with the existing norms [2[for the material milled from the road concrete layer mixed with hydraulic road binder [1] and for the asphalt layer milled and mixed with hydraulic road binder [1].

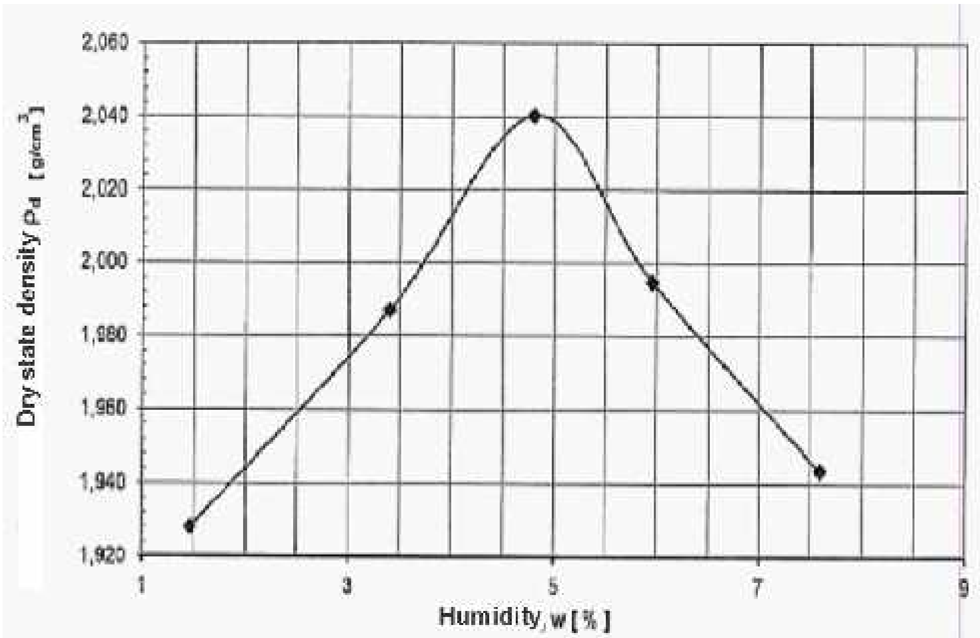
Compaction degree characteristics

Table 1

Compaction characteristics	Sign	Obtained value	
		Road concrete milled	Asphalt layer milled
Optimum humidity	w (%)	6.9	4.8
Maximum density in dry condition	γdmax (g/cm3)	1.983	2.040



(1) – from material milled from road concrete plates



(2) - from material milled from asphaltic mixture layer

Fig. 4. *Modified Proctor diagram on the milled material mixed with hydraulic road binder [1]*

Table 2 presents the compression mechanical resistance at 7 days on the milled road concrete and mixed with hydraulic road binder [1], and Table 3 presents the compression resistance at 7 day on the milled asphalt layer and mixed with hydraulic road binder [1].

Compression mechanical resistance at 7 days on the milled road concrete and mixed with hydraulic road binder Table 2

No	Test age, days	Binder percentage %	Weight of cylinder	Volume	Compaction characteristics		R_{c28} N/mm^2	Average N/mm^2	Norms [2]
					γ_d (g/cm^3)	w_{opt} (%)			
1	7	2.5	842.3	408.9	1.983	6.9	1.632	1.66	1.2...1.8
2	7	2.5	843	408.5	1.983	6.9	1.684		
3	7	2.5	843.1	409.7	1.983	6.9	1.633		

Compression resistance at 7 day on the milled asphlat layer and mixed with hydraulic road binder Table 3

No	Test age, days	Binder percentage %	Weight of cylinder	Volume	Compaction characteristics		R_{c28} N/mm^2	Average N/mm^2	Norms [2]
					γ_d (g/cm^3)	w_{opt} (%)			
1	7	3.5	862,3	410,1	2,04	4,8	1.477	1.51	1.2...1.8
2	7	3.5	863	408.9	2,04	4,8	1.534		
3	7	3.5	863,1	408,9	2,04	4,8	1.53		

In tables 4, 5, 6 and 7 are presented the results obtained through durability tests on the milled material from road concrete plates and on the milled asphalt layer mixed with the hydraulic road binder [1].

Weight loss through saturation/ drying and freeze-thaw on the milled road concrete plate + 2,5% hydraulic road binder [1] Table 4

No	Sample weight (saturation/drying) -grams		Sample weight (freeze - thaw) grams		Weight loss through saturation drying (%)	Weight loss through freeze thaw (%)
	At 7 days	After 14 cycles	After 13+1 days	After 14 cycles		
1	837	813,9	870	818,2	2,75	5,95
2	832	808,3	867	815,5	2,85	5,94
3	835,1	811,4	869,5	817,8	2,84	5,95
Average					2,82	5,95
Technical conditions on foundation layer [3]					-	Max. 7

Stability at water of the milled material from road concrete plate +2.5% hydraulic road binder [1]

Table 5

No	Sample weight (grams)		Sample height (cm)		Sample diameter (cm)	Sample volume		Compresion resistance		Loss on compresion resistance	Volumetric swelling	Water absortion
	At 7 days	At 7+7 immersion	At 7 days	At 7+7 immersion		At 7 days	at 7+7 immersion	Rc7+7 imerssion	Rc14			
1	834	865	10.49	10.56	7.14	419.8	422.6	1.994	2.074	3.86	0.667	3.72
2	823	859.1	10.55	10.618	7.14	422.2	424.9	2.011	2.092	3.87	0.645	4.39
3	830.2	861.5	10.5	10.588	7.14	420.2	422.9	1.988	2.068	3.87	0.648	3.77
Average										3.87	0.65	3.96
Technical conditions on foundation layer [3]										-	-	Max15

Weight loss through saturation/ drying and freeze-thaw on the milled asphalt layer + 3.5% hydraulic road binder [1]

Table 6

No	Sample weight (saturation/drying) -grams		Sample weight (freeze - thaw) grams		Weight loss through saturation drying (%)	Weight loss through freeze thaw (%)
	At 7 days	After 14 cycles	After 13+1 days	After 14 cycles		
1	832	812.6	868.2	815.4	2.38	6.45
2	829	806.5	862.1	813.1	2.78	6.03
3	830.2	807.9	864.6	814.0	2.76	6.21
Average					2.64	6.23
Tehcnical conditions on foundatin layer [3]					-	Max. 7

Stability at water of the milled material from asphalt layer +3.5% hydraulic road binder [1]

Table 7

No	Sample weight (grams)		Sample height (cm)		Sample diameter (cm)	Sample volume		Compression resistance		Loss on compresion resistance	Volumetric swelling	Water absortion
	At 7 days	at 7+7 immersion	At 7 days	at 7+7 immersion		At 7 days	at 7+7 immersion	Rc7+7 imerssion	Rc14			
1	835	865	10.50	10.58	7.14	420.1	424.4	1.883	1.987	5.23	0.685	3.92
2	828.7	857.3	10.56	10.63	7.14	424.3	427.9	1.992	2.065	3.54	0.673	4.78
3	832.1	862.5	10.54	10.60	7.14	422.9	425.8	1.976	2.022	2.27	0.663	4.03
Average										3.68	0.673	4.24
Technical conditions on foundation layer [3]										-	-	Max15

2.2. Cold Recycling in Site Technology

Cold recycling in set technology using hydraulic road binder]1] and water is presented schematic in Figure 5.

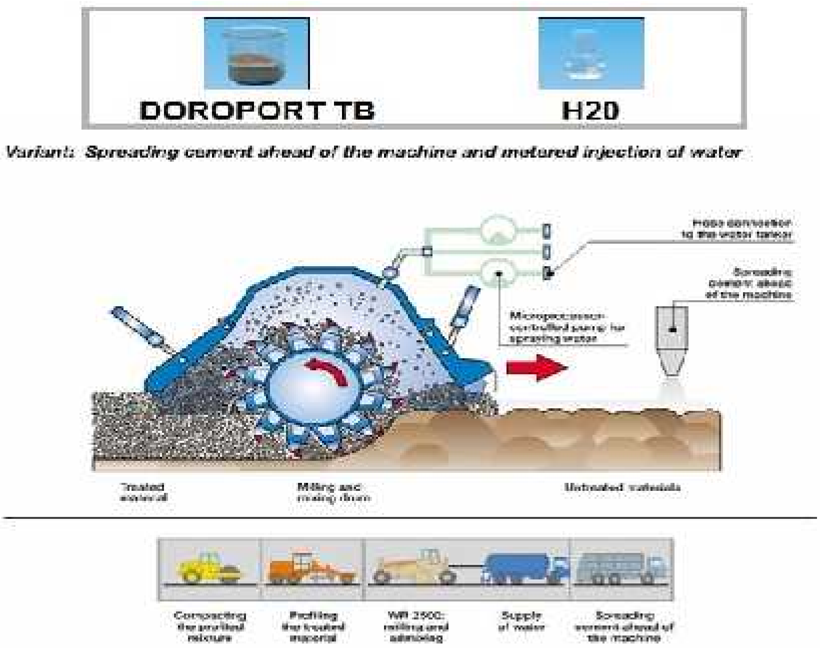


Fig. 5. *Schematic representation of the technology of cold recycling in site using HRB E3 hydraulic road binders*

Technological stages of the in site cold recycling using hydraulic road binder [1] are presented in Figure 6...11.

Fig. 6. *Milling the existing layers and placing them for the stabilization in a belt*

Fig. 7. *Spreading the hydraulic road binder Doroport TB25 in the lab recipe percentage*

Fig. 8. *Cold recycling in site: mixing equipment and water tank*

Fig. 9. *Layers disposal with the auto grader*

Fig. 10. *Compaction*

Fig. 11. *Protection of the recycled layer with a cationic emulsion layer*

For the protection of the layer made from cold recycled material with hydraulic road binder [1] it is applied a cationic emulsion layer.

2.3. Quality Verification of the Works

On site there were made cylinders using the recycled material (Figure 12). The results obtained are presented in Table 8.

Physical – mechanical characteristics obtained on the cylinders made on site

Table 8

No	Laboratory studies	Road concrete plate milled +2.5% hydraulic road binder [1]	Asphalt layer milled+3.5% hydraulic road binder [1]	Technical conditions on foundation layer [3]
1	Bulk density g/cm^3	1.983	2.04	-
2	Compression resistance at 28 days N/mm^2	1.66	1.51	1.2-1.8
3	Loss of compression resistance N/mm^2	3.87	3.68	Max.25
4	Volumetric swelling	0.65	0.673	Max.5
5	Water absorption	3.96	4.24	Max.15
6	Mass loss due to saturation/drying	2.82	2.64	Max.7
7	Mass loss due to freeze thaw	5.95	6.23	Max.7

Fig. 12. *Making the cylinders for the laboratory tests*

3. Conclusions

After the applying of the cold recycling in site technology using hydraulic road binders [1] on the road are obtained foundation layers or base layers with a very good behaviour at the traffic loads and at the water actions, and the physical mechanical characteristics are according to the actual norms [3].

The bearing capacity obtain is according to the initial design and is uniform along the road allowing us to have a long term road durability.

Cold recycling on site is the optimum technical economical solution to be applied for the rehabilitation and the modernization of the roads of all types.

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