Evaluation of Performance of the Roadmesh Reinforcement Pavement at Trial Stretch on Chita-Khabarovsk Autoroad

Mr. Ushakov Victor
Doctor of Technical Science, Professor,Vice-rector for Academic and Educational work in Moscow Automobile and Road Institute (MADI), Russia
E-mail:ushakov@madi.ru

Mr.Inshakov Aleksander
Technical director in Maccaferri CIS
E-mail: inshakov@maccaferri.ru

ABSTRACT: An experimental section of asphalt concrete reinforced with Roadmesh metal mesh was constructed at Chita-Khabarovsk road in August 2008. It was with the participation of specialists from MADI (Moscow), Dorstroykontrol Research and Development Center (Chita), Maccaferri CIS and Zhireken branch of Trud CJSC (Irkutsk). In order to validate and elaborate the asphalt concrete reinforcement technology and for the evaluation of the mesh impact on the bearing capacity of the road pavement, cracking resistance and evenness of the asphalt concrete covering studies were carried out in 2009, 2010 and 2011. The paper presents the studies were carried out during 3 years of the pavement service under severe climatic and permafrost conditions and the results obtained.

1. Introduction

An experimental section of asphalt concrete reinforced with Roadmesh metal mesh was constructed at Chita-Khabarovsk autoroad in August 2008. It was with the participation of specialists from MADI (Moscow), Dorstroykontrol Research and Development Center (Chita), Maccaferri CIS and Zhireken branch of Trud CJSC (Irkutsk). In order to validate and elaborate the asphalt concrete reinforcement technology and for the evaluation of the mesh impact on the bearing capacity of the road pavement, cracking resistance and evenness of the asphalt concrete covering studies were carried out in 2009, 2010 and 2011. The studies were carried out during 3 years of the pavement service under severe climatic and permafrost conditions.

The experimental section is located at km 365 (ПК 143+02 –ПК 144+02, left driving lane) of Chita-Khabarovsk autoroad. The section is in the valley of the Shirga River in Zabaykalye territory which is characterized by continuous permafrost and weak soils of the seasonally active layer of the road bed foundation. The Road pavement structure of Chita-Khabarovsk autoroad experimental section is shown in Fig. 1

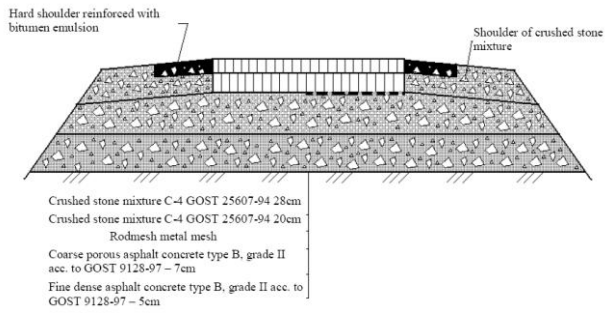

Fig. 1 Road pavement structure of Chita-Khabarovsk autoroad experimental section

2. Evaluation of the Impact of the Road Pavement Reinforcement with Roadmesh- The General Condition of the Asphalt Concrete Covering Surface

The patterns of transverse and longitudinal cracks propagation at km 365 section of Chita-Khabarovsk autoroad (ПК 141+96 – ПК 144+02) are shown in Fig.2 and Fig.3. Studies and monitoring of the experimental sections showed that cracks propagation at the unreinforced section (ПК 141+96 – ПК 143+02), adjacent to the reinforced one (ПК 143+02 – ПК 144+02, left driving lane) was more intense and they were irregular on the covering surface. In general it should be pointed out that laying of Roadmesh metal mesh between the crushed stone foundation and asphalt concrete layers had a certain impact on formation and propagation of cracks in the asphalt concrete.

Fig.2 (a)Transverse crack on experimental section ПК 143+39 (b)Transverse crack on experimental section ПК 143+50

Fig.3 (a)Transverse crack on experimental section ПК 143+85 (b)Transverse crack at the end of experimental section ПК 144+00

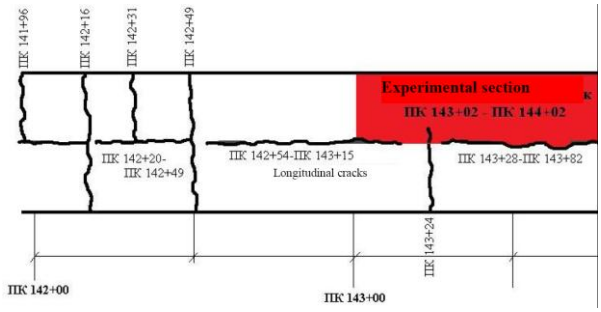

Fig.4 Transverse and longitudinal cracks propagation pattern at Chita-Khabarovsk autoroad section at km 365 (ПК 142+00 –ПК 144+02), revealed in 2009

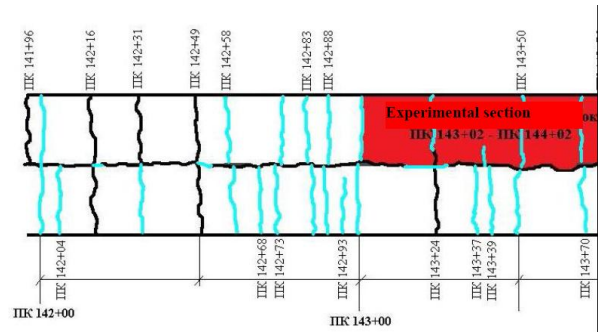

Fig.5 Transverse and longitudinal cracks propagation pattern at Chita-Khabarovsk autoroad section at km 365 (ПК 142+00 –ПК 144+02), revealed in 2011

Studies and monitoring of the experimental sections showed that cracks propagation at the unreinforced section (ПК 141+96 –ПК 143+02), adjacent to the reinforced one (ПК 143+02 –ПК 144+02, left driving lane) was more intense and they were irregular on the covering surface. In general it should be pointed out that laying of Roadmesh metal mesh between the crushed stone foundation and asphalt concrete layers had a certain impact on formation and propagation of cracks in the asphalt concrete (refer Fig.6).

Fig.6 (a) General view of the autoroad experimental section at km 365 (ПК 142+00 –ПК 144+50) - July, 2011 (b) General view of the section of Amur autoroad (Chita-Khabarovsk) at km 365 (ПК 142+00 –ПК 143+00) –July, 2011

3. Evaluation of Reinforcement Impact on the Pavement Surface Evenness

The evenness of the asphalt concrete covering surface of Chita-Khabarovsk autoroad was determined by the "amplitude method", by profile leveling at driving lanes at 5m intervals. Results of surface evenness determination of asphalt concrete covering at Chita Khabarovsk autoroad at km 365 (Пк 142+00 – Пк 144+05) as of 2008 is shown in Table 1. Following are the observations from the study (refer Table 1).

1. At reinforced section ПК 143+02 – ПК 144+02 (left driving lane) 95% of evenness determination results have amplitude values of up to 7mm and 5% - up to 10.5mm;
2. At unreinforced section Пк 143+02 – Пк 144+02 (right driving lane), adjacent to the experimental one on the adjacent driving lane, 70% of evenness determination results have amplitude values of up to 7mm, 25% - up to 10.5mm and 5% - over 10.5 мм;

3. At unreinforced section Пк 142+00 – Пк 143+02, adjacent to the experimental one, 77.5% of evenness determination results have amplitude values of up to 7mm, 20% - up to 10.5mm and 2.5% - over 10.5 mm

Table 1 Results of surface evenness determination of asphalt concrete covering at Chita Khabarovsk autoroad at km 365 (Пк 142+00 – Пк 144+05) as of 2008

	Left driving lane		Right driving lane	
Measurement point, ПК +	**Reference hi, m marks**	**Amplitudes hi, m**	**Reference hi, m marks**	**Amplitudes hi, m**
142+00	2.776	-	2.795	-
142+05	2.648	10.5	2.673	10
142+10	2.541	5.5	2.571	1
142+15	2.445	-6	2.471	-6.5
142+20	2.337	1.5	2.358	-5.5
142+25	2.232	-4	2.234	0.5
142+30	2.119	7	2.111	7
142+35	2.020	3.5	2.002	9.5
142+40	1.928	-2.5	1.912	-1
142+45	1.831	-6.5	1.82	-6.5
142+50	1.721	1	1.715	0
142+55	1.613	7	1.610	4
142+60	1.519	5	1.513	-0.5
142+65	1.435	-6	1.415	
142+70	1.339	-2	1.309	-0.5
142+75	1.239	10.5	1.202	11.5
142+80	1,.6	7	1.118	9.5
142+85	1.095	-8	1.053	-1
142+90	1.014	-7	0.986	-10.5
142+95	0.919	1.5	0.898	4
143+00	0.827	10.5	0.818	2
143+05	0.756	8	0.742	10.5
143+10	0.701	2	0.687	4
143+15	0.650	2.5	0.640	4
143+20	0.604	6.5	0.601	6
143+25	0.571	-5.5	0.574	-2
143+30	0.527	-1	0.543	-8
143+35	0.481	3	0.496	-7
143+40	0.441	-2	0.435	-5.5
143+45	0.397	-6.5	0.363	4.5
143+50	0.340	-2	0.300	-8.5
143+55	0.279	2	0.220	19
143+60	0.222	4.5	0.178	10.5
143+65	0.174	6.5	0.157	-6
143+70	0.139	4	0.124	6
143+75	0.112	2	0.103	10.5
143+80	0.089	7	0.103	1.5
143+85	0.08	-3.5	0.106	-4
143+90	0.064	6	0.101	-2
143+95	0.060	-7	0.092	-7
144+00	0.042	-4	0.069	1
144+05	0.016	-	0.048	-

Similarly, following are the conclusion drawn from the results of the test conducted on asphalt concrete at Chita-Khabarovsk autoroad at km 365 (Пк 142+00 – Пк 144+05) as of 2010.

1. At reinforced section ПК 143+02 – ПкК144+02 (left driving lane) 90% of evenness determination results have amplitude values of up to 7mm and 10% - up to 10.5mm;
2. At unreinforced section ПК 143+02 – ПК 144+02 (right driving lane), adjacent to the experimental one on the adjacent driving lane, 65% of evenness determination results have amplitude values of up to 7mm, 15% - up to 10.5mm and 20% - over 10.5 mm;
3. At unreinforced section ПК 142+00 – ПК 143+02, adjacent to the experimental one, 65% of evenness determination results have amplitude values of up to 7mm, 15% - up to 10.5mm and 20% - over 10.5 mm

Similarly, following are the conclusion drawn from the results of the test conducted on asphalt concrete at Chita-Khabarovsk autoroad at km 365 (Пк 142+00 – Пк 144+05) as of 2011

1. At reinforced section ПК 143+02 – ПК 144+02 (left driving lane) 85% of evenness determination results have amplitude values of up to 7mm, 10% - up to 10.5mm and 5% - over 10.5 mm;
2. At unreinforced section ПК 143+02 – ПК 144+02 (right driving lane), adjacent to the experimental one on the adjacent driving lane, 50% of evenness determination results have amplitude values of up to 7mm, 30% - up to 10.5mm and 20% - over 10.5 mm;
3. At unreinforced section ПК 142+00 – Пк 14К+02, adjacent to the experimental one, 55% of evenness determination results have amplitude values of up to 7mm, 20% - up to 10.5mm and 25% - over 10.5 mm

On the basis of the evenness evaluation of the pavement experimental sections during the period of its service we can draw a conclusion that reinforcement of the road pavement with Roadmesh metal mesh contributes to higher evenness of the asphalt concrete covering during a long period of service. The reinforcement protects the pavement from irregular deformation, especially under the permafrost conditions.

4. Evaluation of Reinforcement Impact on the Bearing Capacity of the Road Pavement

Evaluation of the impact of metal mesh on the bearing capacity of the road pavement was carried out in several steps. At the first stage, the relative variation in the road pavement strength when reinforced with Roadmesh metal mesh was determined directly upon the upper layer of the asphalt concrete covering. At each subsequent stage, the bearing capacity of the road structure in the period of its most weak condition was determined yearly for three years of service (refer Table 2). The MADI-TsNIL lever-type Benkelman beam was used for road pavement strength trials. At the section of Chita-Khabarovsk autoroad the load was applied using different vehicles – ATZ refueler on the basis of MAZ-53370-24 two-axle vehicle with 11.5 t (112.82 kN) load on the back axle and

KDM-130V on the basis of ZIL-130 with 6.3 t (61,8 кН) load on the back axle. The wheel print areas amounted to 1,456 cm^2 and 1,020 cm^2 respectively.

The road pavement elastic modulus was determined using the following formula:

$$E=\frac{p\times D\times(1-\mu^2)}{l_y}, MPa$$

where p – specific wheel pressure on the pavement, MPa;D – diameter of the circle equal to the wheel print, mm;- Poisson's ratio – 0.3;ly – elastic deflection of the road pavement, mm.

Table 2 Results of determination of the road pavement strength at Chita-Khabarovsk autoroad section at km 365 (Пк 142+00 – Пк 144+02) as of the day of commissioning upon completion of the road construction (October, 2008)

Number of points	Elastic modulus, MPa					
	Left			Right		
	General	On the surface of the pavement lower layer	Difference of values	General	On the surface of the pavement lower layer	Difference of values
Adjacent section at km 365 (ПК 142+00 –ПК 143+02)						
1	311	165	146	327	304	24
2	272	249	23	343	330	13
3	259	223	36	400	253	147
4	351	205	146	360	316	44
5	327	171	157	343	262	81
6	320	195	125	400	266	134
7	320	197	123	327	266	61
8	302	161	141	400	345	55
9	330	165	165	343	316	27
10	286	195	92	379	361	18
11	360	183	177	400	370	30
Experimental section at km 365 (ПК 143+02 –ПК 144+02)						
12	351	165	186	351	330	21
13	300	177	124	379	361	18
14	320	183	137	369	266	103
15	343	217	126	343	304	39
16	306	253	53	327	310	18
17	360	276	84	327	316	11
18	313	192	121	379	323	56
19	300	167	133	369	316	53
20	343	185	158	400	330	70

From Table 2, it can be observed that the average values of the road pavement elastic modulus on the surface of the upper layer of the asphalt concrete are the following: at reinforced section ПК 143+02 – ПК 144+02 (left driving lane) -326 MPa; at unreinforced section ПК 142+00 – ПК 143+02, adjacent to the experimental one – 313 MPa, with average strength of the road pavement foundation of 196 MPa. The difference of values of elastic modulus of the road pavement on the asphalt concrete covering surface and the crushed stone foundation are the following: at the experimental section - 130 MPa;at the section adjacent to the experimental one - 117 MPa. Hence laying Roadmesh metal mesh on the crushed stone foundation under a two-layer asphalt concrete covering provides a relative strength enhancement of 11.1%.

Results of the road pavement strength at Chita-Khabarovsk autoroad section at km 365 (Пк 142+00 –Пк 144+02) are enlisted in Table 3. The average values of the elastic modulus on the surface of the upper layer of the asphalt concrete road pavement are 207 MPa and 204 MPa at reinforced section (ПК 143+02 – ПК 144+02) (left driving lane) and at unreinforced section (ПК 142+00 – ПК 143+02), adjacent to the experimental one respectively.

Table 3 Results of the road pavement strength at Chita-Khabarovsk autoroad section at km 365 (Пк 142+00 – Пк 144+02)

No of points	Elastic modulus, MPa	
	Right	Left
Adjacent section at km 365 (ПК 142+00 – ПК 143+02)		
1	207	199
2	237	199
3	199	237
4	195	261
5	207	248
6	221	269
7	195	242
8	191	199
9	231	231
10	181	221
11	177	226
Experimental section at km 365 (ПК 143+02 – ПК 144+02)		
12	221	181
13	221	216
14	231	248
15	191	203

16	216	216
17	187	248
18	191	199
19	199	216
20	207	216

5. Conclusion

Following are the results found out from the trials of the experimental sections conducted at Chita- Khabarovsk autoroad, reinforced with Roadmesh mesh from 2008 to 2011.

1. Laying Roadmesh metal mesh between the crushed stone foundation and the asphalt concrete covering has a positive impact on the propagation of cracks in the asphalt concrete during the service period. At unreinforced sections of the asphalt concrete covering cracks propagation is more intense and they are irregular on the covering surface as compared to the covering section reinforced with Roadmesh metal mesh.
2. Reinforcement with Roadmesh metal mesh protects the pavement from irregular deformation, especially under permafrost conditions. Reinforcement of the road pavement contributes to preservation of the asphalt concrete covering surface evenness for a long period of service.
3. Reinforcement of flexible road pavement with Roadmesh metal mesh contributes to pavement strength enhancement by 10% at the average.
4. It is recommended to reinforce flexible road pavements with Roadmesh metal mesh at the sections with weak soils, at locations under permafrost conditions, at the locations where an even asphalt concrete covering is required for a long period of time.