Universidade do Minho

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Pais, J.C., Pereira, P.A.A., Minhoto, M.J.C., Baptista, A.

"Asphalt pavements recycling with asphalt rubber"

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1033	ANALYSIS OF URBAN PAVEMENT SURFACE PROFILES ORIENTED TO ENVIRONMENTAL PERFORMANCE INDICATORS.	Nicolosi, Vittorio
1137	A MIXTURE MODEL FOR PREDICTING PATTERNS OF SPATIAL REPEATABILITY IN HEAVY VEHICLE FLEETS	Obrien, Eugene
1080	AN ALTERNATIVE DEFLECTION ANALYSIS FOR THE EVALUATION OF THE PAVEMENT CONDITION	Oliveira, Joel
1077	STUDY ON THE CONSEQUENCES OF AFFIXING THE CE MARKING TO BITUMINOUS MIXTURES	Palha, Carlos
1071	LABORATORY OPTIMIZATION OF CONTINUOUS BLEND ASPHALT RUBBER	Pereira, Paulo
1072	SKID RESISTANCE AND TEXTURE OF COMPACTED ASPHALT MIXES EVALUATED BY THE IFI IN LABORATORY	Pereira, Paulo
1013	MULTIDIMENSIONAL APPROACH TO DESCRIBE BRIDGE DETERIORIATION	Petschacher, Markus
1112	A MAINTENANCE MANAGEMENT SYSTEM FOR THE STATE OF RIO GRANDE DO SUL PAVED ROADS	Pinto, Paulo
1019	ROAD ASSET MANAGEMENT –MAIN MAINTENANCE MEASURES: BACKLOG AND EFFECTIVENESS	Potucek, Jaro
1029	ROAD ASSET MANAGEMENT AND TRANSPORTATION OF HAZARDOUS MATERIALS	Praticò, Filippo
1090	SPANISH NATIONAL ROAD NETWORK PAVEMENT MANAGEMENT SYSTEM	Rojo, Álvaro Navareño
1066	THE EFFECT OF DRAINAGE CONDITION ON THE LIFETIME OF PAVED ROADS IN NORTHERN EUROPE	Saarenketo, Timo
1139	CONSIDERING ROBUSTNESS OBJECTIVES IN A ROAD NETWORK PLANNING MODEL	Santos, Bruno
1083	SPEED MANAGEMENT IN REGIONAL AND NATIONAL SINGLE CARRIAGEWAY THROUGH ROADS: AN INTEGRATED APPROACH	Silva, Ana Maria
1075	INFLUENCE OF TEMPERATURE ON THE FATIGUE LIFE OF FLEXIBLE PAVEMENTS	Silva, Hugo
1017	THE NEW AUSTRIAN METHOD FOR THE STRUCTURAL ASSESSMENT OF PAVEMENT CONSTRUCTIONS FOR PMS PURPOSES	Simanek, Petra
1048	ENGINEERING STRUCTURES MANAGEMENT SYSTEM:EXAMPLE ON A FRENCH HIGHWAY NETWORK	Simon, Isabelle
1031	IMPLEMENTATION OF A STOCHASTIC PMS MODEL	Socina, Mihai
1059	MIX DESIGN FOR COLD-IN-PLACE PAVEMENT RECYCLING; DOES IT GUARANTEE PERFORMANCE?	Sufian, Zulakmal
1006	CHARACTERIZATION OF ROAD BASES AND SUBBASES MADE OF RECLAIMED ASPHALT PAVEMENT AND RECYCLED CONCRETE AGGREGATE	Taha, Ramzi
1118	CONTRIBUTION OF THE STATE ROAD REHABILITATION TO TRAFFIC SAFETY	Vajdić, Marko
1065	EFFECT OF ASPHALT LAYER THICKNESS VARIABILITY ON PREDICTED FLEXIBLE PAVEMENT LIFE	Valle, Paola Dalla
1114	ROAD NETWORK:RESOURCE MANAGEMENT FOR ITS MAINTENANCE	Varela, Fernando
1096	TRAFFIC SIMULATION TOOLS APPLIED TO PAVEMENT DESIGN	Vasconcelos, António
1018	SECTION BASED PROBABILISTIC PERFORMANCE PREDICTION FICTION OR FUTURE?	Weninger-Vycudil, Alfred
1014	TRANSPORTATION ASSET MANAGEMENT IN THE UNITED STATES	Wlaschin, Julius B.

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General Program

Day 0	**Sunday, 6 July 2008**		
15:00 - 19:00	Registration (DEC main hall, level 2)		
Day 1	**Monday, 7 July 2008**		
08:00 - 17:00	Registration (DEC main hall, level 2)		
09:00 - 10:00	Opening Session (Room: Auditorio Laginha Serafim, level 3)		
10:00 - 11:00	Invited Lecturer (Room: Auditorio Laginha Serafim, level 3)		
11:00 - 11:30	Exhibition Inauguration and Coffee break (level 4)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
11:30 - 13:00	Session A1 Modelling Asset Performance - part 1	Session B1 Asset Condition Evaluation - part 1	
13:00 - 14:20	Lunch (tent with exit from Exhibition level, level 4)		
14:20 - 16:05	Session A2 Modelling Asset Performance - part 2	Session B2 Asset Condition Evaluation - part 2	
16:05 - 16:25	Coffee break (level 4)		
16:25 - 18:10	Session A3 Implementation of Management Systems - part1	Session B3 Asset Management - part 1	
18:15 - 20:00			COST 354
20:30 - 23:30	Reception at Sé Velha (Old Cathedral near the old campus of the University of Coimbra)		
Day 2	**Tuesday, 8 July 2008**		
08:00 - 17:00	Registration (DEC main hall, level 2)		
09:00 - 10:00	Invited Lecturer (Room: Auditorio Laginha Serafim, level 3)		
10:00 - 10:20	Coffee break (level 4)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
10:20 - 11:30	Session A4 Implementation of Management Systems - part2	Session B4 Asset Management - part 2	
11:30 - 13:10	Session A5 Pavement Technologies - part1	Session B5 Asset Manag. and Implem. of Manag. Sys - part 3	
13:10 - 14:20	Lunch (tent with exit from Exhibition level, level 4)		
14:20 - 16:05	Session A6 Pavement Technologies - part2	Session B6 Pavement Technologies - part3	DAWG
16:05 - 17:00	Session A7 Pavement Technologies - part4	Session B7 Pavement Technologies - part5	DAWG
17:00 - 17:30	Coffee break (level 4)		
17:30 - 18:15	Closing Session (Room: Auditorio Laginha Serafim, level 3)		
19:30 - 00:30	Banquet at Convento de Sandelgas (Sandelgas is about 20 km from Coimbra using EN 111 national highway)		
Day 3	**Wednesday, 9 July 2008**		
08:00 - 20:30	Technical Visit to Operations Centre of BRISA (main Portuguese motorways concessionaire) and visit to Sintra and the sea side at S. Martinho do Porto and Nazaré		

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Sessions Program

Day 0	**Sunday, 6 July 2008**		
15:00 - 19:00	Registration (DEC main hall, level 2)		
Day 1	**Monday, 7 July 2008**		
08:00 - 17:00	Registration (DEC main hall, level 2)		
09:00 - 10:00	Opening Session (Room: Auditorio Laginha Serafim, level 3)		
10:00 - 11:00	"ASSET MANAGEMENT IN PRACTICE" by Hamid Zarghampour (Room: Auditorio Laginha Serafim, level 3)		
11:00 - 11:30	Exhibition Inauguration and Coffee break (level 4)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
11:30 - 13:00	Session A1 Modelling Asset Performance - part 1	Session B1 Asset Condition Evaluation - part 1	
11:30 - 11:42	**A1.1** - FACTORS INFLUENCING THE RELIABILITY OF PAVEMENT PERFORMANCE MODELS L. Gáspár (ref. 1116)	**B1.1** - COST 354 - PERFORMANCE INDICATORS FOR ROAD PAVEMENTS J. Litzka, B. Leben, F. La Torre, A. Weninger-Vycudil, M. L. Antunes (ref. 1028)	
11:42 - 11:54	**A1.2** - DEVELOPMENT OF A TECHNICO-ECONOMIC OPTIMIZATION MODEL FOR PAVEMENT MAINTENANCE WORKS P. Lepert, F. Brillet (ref. 1060)	**B1.2** - THE NEW AUSTRIAN METHOD FOR THE STRUCTURAL ASSESSMENT OF PAVEMENT CONSTRUCTIONS FOR PMS PURPOSES A. Weninger-Vycudil; P. Simanek (ref. 1017)	
11:54 - 12:06	**A1.3** - BREAKING THE SILOS IN ASSET MANAGEMENT: COMPREHENSIVE OPTIMIZATION IN LONG-TERM PLANNING OVER MULTIPLE ASSET TYPES D. Mrawira, L. Amador (ref. 1053)	**B1.3** - FAMLIT- A NEW PAVEMENT ASSESSMENT TOOL N. Michel, R. Hassan, J. Roberts (ref. 1003) - Tim Martin	
12:06 - 12:18	**A1.4** - SECTION BASED PROBABILISTIC PERFORMANCE PREDICTION FICTION OR FUTURE? A. Weninger-Vycudil, G. Samek, T. Rohringer (ref. 1018)	**B1.4** - BASIC PARAMETERS OF OPTIMUM, COST-EFFECTIVE BRIDGE MAINTENANCE AND REHABILITATION L. Lublóy (ref. 1041)	
12:18 - 12:30	**A1.5** - MULTIDIMENSIONAL APPROACH TO DESCRIBE BRIDGE DETERIORIATION M. Petschacher, K. Gragger (ref. 1013)	**B1.5** - SKID RESISTANCE AND TEXTURE OF COMPACTED ASPHALT MIXES EVALUATED BY THE IFI IN LABORATORY G. Trichês, L. Fontes, J. Pais, A. Ferreira, P. Pereira (ref. 1056)	
12:30 - 12:42	**A1.6** - A ROAD USER COSTS MODEL FOR PORTUGUESE TRUNK ROADS B. Santos, L. Picado-Santos, V. Cavaleiro (ref. 1027)	**B1.6** - VARIATION OF THE INTERNATIONAL ROUGHNESS INDEX VALUES IN FUNCTION OF THE HEAVY TRAFFIC L. Petho, C. Toth (ref. 1072)	
12:42 - 13:00	DISCUSSION	DISCUSSION-B1	
13:00 - 14:20	Lunch (tent with exit from Exhibition level, level 4)		

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Sessions Program

Day 1	Monday, 7 July 2008		
08:00 - 17:00	Registration (DEC main hall, level 2)		
13:00 - 14:20	Lunch (tent with exit from Exhibition level, level 4)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
	Session A2	Session B2	
14:20 - 16:05	Modelling Asset Performance - part 2	Asset Condition Evaluation - part 2	
14:20 - 14:32	**A2.1** - MULTI-CRITERIA OPTIMIZATION APPLICATIONS IN HIGHWAY ASSET MANAGEMENT	**B2.1** - AN ALTERNATIVE DEFLECTION ANALYSIS FOR THE EVALUATION OF THE PAVEMENT CONDITION	
	Z. Wu, G. Flintsch, A. Ferreira, L. Picado-Santos (ref. 1129)	J. Oliveira, H. Silva, P. Pereira, A. Almeida (ref. 1080)	
14:32 - 14:44	**A2.2** - A MIXTURE MODEL FOR PREDICTING PATTERNS OF SPATIAL REPEATABILITY IN HEAVY VEHICLE FLEETS	**B2.2** - EFFECT OF ASPHALT LAYER THICKNESS VARIABILITY ON PREDICTED FLEXIBLE PAVEMENT LIFE	
	N. Harris, E. Obrien, S. Wilson (ref. 1137)	P. Valle, A. Collop, N. Thom (ref. 1065)	
14:44 - 14:56	**A2.3** - ANALYSIS OF PAVEMENT PERFORMANCE MODELS FOR USE IN PAVEMENT MANAGEMENT SYSTEMS	**B2.3** - IDENTIFYING STRUCTURAL CHANGES IN PAVEMENT PROFILES FROM TRAFFIC SPEED DEFLECTOGRAPH DATA USING MML INFERENCE	
	A. Ferreira, L. Picado-Santos, Z. Wu, G. Flintsch (ref. 1136)	M. Byrne (ref. 1061)	
14:56 - 15:08	**A2.4** - TRAFFIC DEPENDENT MARKOV TYPE MULTIPERIOD PMS MODEL	**B2.4** - ANALYSIS OF URBAN PAVEMENT SURFACE PROFILES ORIENTED TO ENVIRONMENTAL PERFORMANCE INDICATORS	
	A. Bakó, K. Ambrus-Somogyi, T. Hartványi, I. Szüts (ref. 1130)	V. Nicolosi, M. D'Apuzzo, B. Festa, L. Mancini (ref. 1033)	
15:08 - 15:20	**A2.5** - ACCIDENT PREDICTION MODELS FOR URBAN AREAS A STATE-OF-THE-ART	**B2.5** - PRELIMINARY RESULTS OF A 2 GHZ HORN ANTENNA GPR ON A PAVEMENT SECTION IN PORTUGAL	
	S. Gomes, J. Cardoso, C. Carvalheira, L. Picado-Santos (ref. 1120)	A. Costa, A. Correia (ref.1143)	
15:20 - 15:32	**A2.6** - MODELING ROAD-TYRE NOISE	**B2.6** - TOWARDS NOISE CLASSIFICATION OF ROAD PAVEMENTS	
	M. Martins, L. Picado-Santos, E. Freitas (ref. 1104)	E. Freitas, J. Paulo, J. Coelho, P. Pereira (ref. 1142)	
15:32 - 15:44	**A2.7** - TRAFFIC SIMULATION TOOLS APPLIED TO PAVEMENT DESIGN	**B2.7** - CONDITION ASSESSSMENT ON CYCLE PATHS WITH A NEWLY DEVELOPED MEASURING TECHNOLOGY	
	A. Vasconcelos, A. Silva , A. Seco, J. Silva (ref. 1096)	R. Anger, A. Schniering (ref. 1082)	
15:44 - 16:05	DISCUSSION	DISCUSSION-B2	
16:05 - 16:25	Coffee break (level 4)		

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Sessions Program

Day 1	Monday, 7 July 2008		
08:00 - 17:00	Registration (DEC main hall, level 2)		
16:05 - 16:25	Coffee break (level 4)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
	Session A3	Session B3	
16:25- 18:10	Implementation of Management Systems - part1	Asset Management - part 1	
16:25 - 16:37	**A3.1** - MAINTENANCE MANAGEMENT FOR THE CLASSIFIED ROAD NETWORK A. Künkel-Henker, Mario Krmek (ref. 1026)	**B3.1** - LIFETIME ENGINEERING IN ROAD ASSET MANAGEMENT L. Gáspár (ref. 1000)	
16:37 - 16:49	**A3.2** -IMPLEMENTATION OF A COMMUNAL PMS IN GERMANY - STATE-OF-THE-ART R. Roos, M. Stöckner, A. Grossmann (ref. 1009)	**B3.2** - TRANSPORTATION ASSET MANAGEMENT IN THE UNITED STATES J. Wlaschin (ref. 1014)	
16:49 - 17:01	**A3.3** - A MAINTENANCE MANAGEMENT SYSTEM FOR THE STATE OF RIO GRANDE DO SUL PAVED ROADS R. Rodrigues, F. Gonçalves, P. Pinto, E. Taffe Jr. (ref. 1112)	**B3.3** - ROAD ASSET MANAGEMENT –MAIN MAINTENANCE MEASURES: BACKLOG AND EFFECTIVENESS J. Potucek (ref. 1019)	
17:01 - 17:13	**A3.4** - PAVEMENT MANEGEMENT SYSTEM OF EP - ESTRADAS DE PORTUGAL, S.A. STRUCTURE AND THE F. Pereira, E. Duarte, T. Moital (ref. 1113)	**B3.4** - HARMONIZATION OF PROJECT AND STRATEGIC LEVEL PAVEMENT MANAGEMENT K. Tsunokawa, G. Mladenovic, A. Djurekovic, S. Marin (ref. 1099)	
17:13 - 17:25	**A3.5** - CONTRIBUTIONS TO THE DEVELOPMENT OF THE PORTUGUESE ROAD ADMINISTRATION'S PAVEMENT L. Picado-Santos, A. Ferreira (ref. 1138)	**B3.5** - BRIDGE MANAGEMENT PLAN AND STRATEGY B. Kuvačić, S. Jurić (ref. 1008)	
17:25 - 17:37	**A3.6** - PAVEMENT MANAGEMENT SYSTEM ON A FRENCH HIGHWAY NETWORK C. Giacobi, E. Layerle (ref. 1141)	**B3.6** - SUSTAINING INFRASTRUCTURE SERVICES BY APPLICATION OF ASSET MANAGEMENT H. Altena, R. Kuijper, B. Mante (ref. 1021)	
17:37 - 17:49	**A3.7** - IMPLEMENTATION OF A STOCHASTIC PMS MODEL M. Socina (ref. 1031)	**B3.7** - PRIVATE PARTICIPATION IN MANAGING ROAD ASSETS O. Gutiérrez-Bolivar, M. Torrens (ref. 1045)	
17:49 - 18:10	DISCUSSION	DISCUSSION	
18:15 - 20:00			COST 354
20:30 - 23:30	Reception at Sé Velha (Old Cathedral near the old campus of the University of Coimbra)		

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Sessions Program

Day 2	Tuesday,8 July 2008		
08:00 - 17:00	Registration (DEC main hall, level 2)		
09:00 - 10:00	MECHANISTIC-EMPIRICAL PAV. DSGN. AND PERF. PREDICTION, OPPORT. AND CHALL. FOR PMS by Gerardo Flintsch (Room: Auditorio Laginha Serafim, level 3)		
10:00 - 10:20	Coffee break (level 4)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
	Session A4	Session B4	
10:20 - 11:30	Implementation of Management systems - part 2	Asset Management - part 2	
10:20 - 10:32	**A4.1** - DEVELOPMENT OF THE HUNGARIAN HIGHWAY ASSET MANAGEMENT L. Gáspár (ref. 1117)	**B4.1** -A NEW DETERMINISTIC OPTIMIZATION MODEL PROPOSED TO BE USED IN THE PMS OF A PORTUGUESE MUNICIPALITY S. Meneses, A. Ferreira, L. Picado-Santos, P. Pereira (ref. 1015)	
10:32 - 10:44	**A4.2** - ROAD NETWORK:RESOURCE MANAGEMENT FOR ITS MAINTENANCE F. Soto, R. Loranca (ref. 1114)	**B4.2** -INTEGRATION OF PAVEMENT MANAGEMENT SYSTEMS AND BRIDGE MANAGEMENT SYSTEMS L. Neves, A. Ferreira (ref. 1054)	
10:44 - 10:56	**A4.3** -PAVEMENT MANAGEMENT SYSTEM ON THE STRATEGIC AND OPERATIVE LEVEL S. Heller (ref. 1024)	**B4.3** -HIGH PRODUCTIVITY VEHICLES AND PAVEMENT ECONOMIC IMPACTS R. Hassan, T. Thoresen,T. Martin, R. Roper (ref. 1002)	
10:56 - 11:18	**A4.4** - ENGINEERING STRUCTURES MANAGEMENT SYSTEM:EXAMPLE ON A FRENCH HIGHWAY NETWORK I. Simon, M. Trains (ref. 1048)	**B4.4** -ROAD ASSET MANAGEMENT AND TRANSPORTATION OF HAZARDOUS MATERIALS F. Praticò, R. Ammendola, A. Moro (ref. 1029)	
11:18-11:30	Discussion	Discussion	
11:30 - 13:10	Session A5	Session B5	
	Pavement Technologies - part1	Asset Manag. and Implem. of Manag. Sys - part 3	

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EPAM3 — July 7 - 9, 2008 Coimbra PORTUGAL

Sessions Program

Day 2	Tuesday,8 July 2008		
08:00 - 17:00	Registration (DEC main hall, level 2)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
10:20 - 11:30	Session A4 Implementation of Management systems - part 2	Session B4 Asset Management - part 2	
11:30 - 13:10	Session A5 Pavement Technologies - part 1	Session B5 Asset Manag. and Implem. of Manag. Sys - part 3	
11:30 - 11:42	**A5.1** - TECHNOLOGIES FOR THIN-LAYER MAINTENANCE **A. Marquardt**	B5.1 - SPEED MANAGEMENT IN REGIONAL AND NATIONAL SINGLE CARRIAGEWAY THROUGH ROADS: AN INTEGRATED APPROACH A. Seco, A. Silva, C. Galvão (ref. 1083)	
11:42 - 11:54	**A5.2** - A. Marquardt (ref. 1145)	**B5.2** -CONSIDERING ROBUSTNESS OBJECTIVES IN A ROAD NETWORK PLANNING MODEL B. Santos, A. Antunes (ref. 1139)	
11:54 - 12:06	**A5.3** - MIX DESIGN FOR COLD-IN-PLACE PAVEMENT RECYCLING; DOES IT GUARANTEE PERFORMANCE? Z. Sufian, N. Aziz, M. Motori, M. Hussain (ref.1059)	**B5.3** - ROADEX – A ROADS TECHNICAL COLLABORATION ACROSS THE EUROPEAN NORTHERN PERIPHERY R. Munro, T. Saarenketo, K. Palo (ref. 1081)	
12:06 - 12:18	**A5.4 (ex- A6.2)** - LABORATORY OPTIMIZATION OF CONTINUOUS BLEND ASPHALT RUBBER L. Fontes, P. Pereira, G. Trichês, J. Pais, R. Luzia (ref. 1071)	**B5.4** - THE USE OF DATA MINING TECHNIQUES FOR ROAD MAINTENANCE PLANNING B. Festa, L. Sparavigna, G. Giuliana (ref. 1093)	
12:18 - 12:30	**A5.5** - PERFORMANCE-BASED MIX DESIGN METHOD FOR BITUMINOUS HOT-MIX RECYCLING IN PLANT A. Baptista, L. Picado-Santos, S. Capitão, J. Oliveira (ref. 1088)	**B5.5** - CONTRIBUTION OF THE STATE ROAD REHABILITATION TO TRAFFIC SAFETY M. Sršen, N. Sukalić, M. Vajdić (ref. 1118)	
12:30 - 12:42	A5.6 - CHARACTERIZATION OF ROAD BASES AND SUBBASES MADE OF RECLAIMED ASPHALT PAVEMENT AND RECYCLED CONCRETE AGGREGATE R. Taha, K. Alshamsi (ref. 1006)	**B5.6** -SPANISH NATIONAL ROAD NETWORK PAVEMENT MANAGEMENT SYSTEM A. Navareño, V. Gómez (ref. 1090)	
12:42 - 12:54	DISCUSSION	B5.7 - ROAD SAFETY MANAGEMENT IN LISBON: DEVELOPMENT OF EFFICIENT CORRECTIVE SAFETY MEASURES C. Carvalheira, L. P.-Santos, S. Gomes, J. Cardoso (ref. 1119)	
12:54 - 13:10	DISCUSSION	DISCUSSION	
13:10 - 14:20	Lunch (tent with exit from Exhibition level, level 4)		

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EPAM3 — July 7 - 9, 2008 Coimbra PORTUGAL

Sessions Program

Day 2	Tuesday, 8 July 2008		
08:00 - 17:00	Registration (DEC main hall, level 2)		
13:10 - 14:20	Lunch (tent with exit from Exhibition level, level 4)		
	Room: Auditorio Laginha Serafim (level 3)	**Room: AFD 3.1 (level 3)**	**Room: SE 4.2 (level 4)**
14:20 - 16:05	Session A6 Pavement technologies - part 2	Session B6 Pavement technologies - part 3	DAWG
14:20 - 14:32	**A6.1** - THE USE OF THE GYRATORY COMPACTOR IN THE DESIGN OF PORTUGUESE BITUMINOUS MIXTURES D. Gardete, L. Picado-Santos, S. Capitão, H. Silva (ref. 1087)	**B6.1** - EVALUATION OF SOIL-CEMENT STRENGTHS IN REGIONAL ROADS OF CASTILLA Y LEÓN J. Berzosa, H. Orden (ref. 1091)	
14:32 - 14:44	**A6.2 (ex- A5.4)** - RECYCLING OF ASPHALT PAVEMENTS WITH ASPHALT RUBBER J. Pais, P. Pereira, M. Minhoto, A. Baptista (ref. 1068)	**B6.2** - MECHANICAL BEHAVIOUR OF TWO CRUSHED MATERIALS USED IN PORTUGUESE UGL R. Luzia, L. Picado-Santos, P. Pereira (ref. 1095)	
14:44 - 14:56	**A6.3** - A COMPARISON BETWEEN THE LIFE OF A RECYCLED ASPHALT PAVEMENT AND A NEW ONE M. Centeno, H. Orden, A. Martínez (ref. 1089)	**B6.3** - NEW AND OLD TECHNOLOGIES FOR THE DETERMINATION OF DENSITY OF HMAs F. Praticò, A. Moro, R. Ammendola (ref. 1030)	
14:56 - 15:08	**A6.4** - ASPHALT RUBBER MIXTURES IN PORTUGAL: FATIGUE RESISTANCE H. Miranda, F. Batista, J. Neves, M. Antunes, P. Fonseca (ref. 1092)	**B6.4** - DEM SIMULATION OF FIELD ASPHALT COMPACTION R. Micaelo, M. Azevedo, J. Ribeiro, N. Azevedo (ref. 1067)	
15:08 - 15:20	**A6.5** - INFLUENCE OF TEMPERATURE ON THE FATIGUE LIFE OF FLEXIBLE PAVEMENTS H. Silva, J. Oliveira, L. Picado-Santos (ref. 1075)	**B6.5** - STUDY ON THE CONSEQUENCES OF AFFIXING THE CE MARKING TO BITUMINOUS MIXTURES H. Silva, C. Palha, D. Gardete, S. Capitão (ref. 1077)	
15:20 - 15:32	**A6.6** - RUTTING COMPARISON OF LABORATORY AND FIELD SAMPLES WITH VERIFIED REPEATED CREEP TESTS IN ASPHALT MIXTURES A. Aksoy, E. Iskender, H. Ozen (ref. 1106)	**B6.6** - MANAGEMENT OF SURFACE CHARACTERISTICS OF ASPHALT PAVEMENTS BY MEANS OF THE APPLICATION OF MICROGRINDING AND BLASTING TECHNIQUES J. Marcobal (ref. 1133)	
15:32 - 15:44	**A6.7** - THE TRAFFIC AND TEMPERATURE EFFECT ON THE REFLECTIVE CRACKING M. Minhoto, J. Pais, P. Pereira (ref. 1135)	**B6.7** - EXPERIMENTAL ANALYSIS OF INNOVATIVE JOINTS IN REHABILITATION OF AIRPORT PAVEMENTS G. Rios, F.Fiori, M. Pozzi (ref. 1035)	
15:44 - 16:05	DISCUSSION	DISCUSSION	
16:05 - 17:00	Session A7 Pavement Technologies - part4	Session B7 Pavement Technologies - part5	DAWG

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Day 2	Tuesday, 8 July 2008		
14:20 - 16:05	Session A6 Pavement technologies - part 2	Session B6 Pavement technologies - part 3	DAWG
16:05 - 17:00	Session A7 Pavement technologies - part 4	Session B7 Pavement technologies - part 5	DAWG
16:05 - 16:17	**A7.1** -CHARACTERISTICS OF ASPHALT BINDERS MODIFIED WITH THE INCORPORATION OF RECLYCLED CRUMBLED RUBBER J. Dias, L. Picado-Santos (ref. 1144)	**B7.1** - PAVEMENT IMPACTS ON HIGHWAY RUNOFF QUALITY– ARE COASTAL AREAS SPECIAL CASES? P. Antunes, A. Barbosa (ref. 1132)	
16:17 - 16:29	**A7.2** -EVALUATING EFFECT OF FILM THICKNESS ON AGING OF ASPHALT THROUGH THIN FILM OVEN TEST R. Choundhary, S. Chandra (ref. 1070)	**B7.2** - THEORETICAL BASIS FOR THE TREATMENT OF LONG DRAINAGE PATHS ON MOTORWAYS G. Griffiths, P. Valle (ref. 1064)	
16:29 - 16:41	**A7.3** - RELATION BETWEEN ZERO SHEAR VISCOSITY AND ZERO FREQUENCY COMPLEX VISCOSITY AT DIFFERENT TEMPERATURES V. Nguyen, G. Airey, M. Liao (ref. 1078)	**B7.3** - THE EFFECT OF DRAINAGE CONDITION ON THE LIFETIME OF PAVED ROADS IN NORTHERN EUROPE T. Saarenketo (ref. 1066)	
16:41 - 17:00	DISCUSSION	DISCUSSION	
17:00 - 17:30	Coffee break (level 4)		
17:30 -18:15	Closing Session (Room:Auditório Laginha Serafim,Level 3)		
19:30 - 00:30	Banquet at Convento de Sandelgas (Sandelgas is about 20 km from Coimbra using EN 111 national highway)		

Day 3	Wednesday, 9 July 2008
08:00 - 20:30	Technical Visit to Operations Centre of BRISA (main Portuguese motorways concessionaire) and visit to Sintra and the sea side at S. Martinho do Porto and Nazaré

RECYCLING OF ASPHALT PAVEMENTS WITH ASPHALT RUBBER

Jorge Pais[1], Paulo Pereira[1], Manuel Minhoto[2] and António Baptista[3]
[1]University of Minho, Guimarães, Portugal
[2] Polytechnic Institute of Bragança, Bragança, Portugal
[3] Polytechnic Institute of Viseu, Viseu, Portugal
E-mail: jpais@civil.uminho.pt; ppereira@civil.uminho.pt; minhoto@ipb.pt; baptista@dcivil.estv.ipv.pt

Abstract

Pavement recycling has been an important rehabilitation technique to deal with reclaimed materials from old pavements which are usually sent to landfills. The application of this technique contributes to: i) the accomplishment of the requirements defined by the European legislation for the amount of material sent to landfills; ii) the reduction in the use of new raw materials used to produce pavement layers. The reduction of materials to be used in pavement rehabilitation has also been possible through the use of asphalt rubber binder (i.e. asphalt modified by crumb rubber from ground tyres) in the production of asphalt mixtures. These mixtures, named asphalt rubber mixtures, have shown an excellent performance in pavement rehabilitation in terms of fatigue and reflective cracking. This behaviour is based on the physical properties of the asphalt rubber which are transferred from the rubber to the net asphalt. The use of asphalt rubber in pavement recycling produces a binder which is a blend of the reclaimed mix binder and the new asphalt rubber added to the reclaimed asphalt mix. This recycled binder presents properties mainly based on recycling rates and on the binders used in recycling. The behaviour of the recycled mixture depends on these factors. This paper presents the results of the properties evaluated for recycled mixtures derived from the type of binder presented in the reclaimed asphalt mix and recycling rate. The influence of the reclaimed asphalt mixes and recycling rate was studied to optimize the behaviour of the recycled mixtures. The mechanical performance in terms of stiffness and fatigue resistance was also evaluated for the recycling design process.

INTRODUCTION

Hot mix asphalt recycling in plant is defined as a technique to produce hot mix asphalt in plant with a certain percentage of reclaimed asphalt granulates as raw material. This percentage can vary between 0 % and almost 100 %, depending on the type of plant and the type of mixture to be produced. Recycling is the re-use of (waste) materials in the same way they had been used for their initial purpose (PIARC, 2003). This process involves the aim of extending the life and usefulness of something that seems to have no more purpose.

Recycling of road pavements have become effective during the last few years by the recycling of old pavements and by the use of crumb rubber recycled from ground tyres. The recycling of reclaimed asphalt mixtures is well known and used worldwide to recover used material and to reduce the use of new ones. The recycling of rubber from ground tyres is also a very used process to modify asphalt in order to produce asphalt rubber with which asphalt rubber mixtures are obtained. These mixtures present an excellent performance in pavement rehabilitation due to the properties of the asphalt rubber binder.

The application of asphalt rubber binder in pavement recycling is very recent. Tia and Ruth (2003), from the USA, were pioneers in this process. They carried out laboratory investigation to determine if the amount of crumb rubber in asphalt rubber had any adverse effects on the recycling and recycled mix properties.

The research allowed concluding that the recycling of mixtures with 33 and 50% of reclaimed asphalt mix are insensitive to the crumb rubber content up to 9% of the total binder. The use of 20% of crumb rubber in the binder of a recycled mixture with 40% of reclaimed asphalt mix can be combined with 60% virgin aggregate without incurring in any significant problems in construction and in service performance, provided that the aggregate gradation of the mixture is properly selected.

The use of crumb rubber modifier in hot mix asphalt mixtures can be traced back to the 1940s, when natural rubber was introduced into asphalt to increase its engineering performance. Since the 1960s, researchers and engineers have used crumb rubber recycled from used tyres in hot mix asphalt mixtures (Pais et al, 2008).

Considering the performance of asphalt rubber mixes, mainly in pavement overlays, pavement rehabilitation using recycled pavements should be carried out with asphalt rubber to increase the pavement overlay life due to reflective cracking. In this case, the existing pavement is milled and the reclaimed asphalt mix is used to produce a new mix by adding raw aggregates and an asphalt rubber binder.

The results presented in this work summarize part of a project in which the study of pavement recycling with asphalt rubber is the main goal. The project studied two reclaimed asphalt mixes to produce recycled mixtures in which the raw materials are composed of new aggregates and asphalt rubber. The main goal of this project is the study of the performance of recycled mixtures for several design parameters, such as asphalt rubber properties, recycling ratio and reclaimed asphalt characteristics. The performance of recycled mixes will be evaluated through fatigue, permanent deformation and reflective cracking resistance. The last two properties will be evaluated afterwards.

The part of the project presented in this paper shows: i) the characterization of the reclaimed asphalt mixtures; ii) the design of the asphalt rubber to be used in the recycling; iii) the prediction of the recycled binder properties (i.e. the binder resulting from the addition of the asphalt rubber to the binder of the reclaimed asphalt mixture); iv) the evaluation of the mechanical properties of the recycled mixtures in terms of stiffness and fatigue resistance.

RECLAIMED ASPHALT MIXTURES

For this study two sources of reclaimed asphalt mixtures were obtained from two different pavements under rehabilitation. The materials correspond to old wearing courses milled by the traditional process resulting in a material with an aggregate gradation different from the one used to produce the original material. Due to the climatic influence, the binder presents characteristics that are different from those of the original binder, mainly in terms of stiffness. The reclaimed asphalt mixtures, F1 and F2, were tested in laboratory in order to characterize their physical properties, i.e. aggregate gradation and asphalt content; the binder was recovered to evaluate: i) penetration; ii) softening point; iii) apparent viscosity. These values are presented in Table 1. The penetration of the recovered asphalt was reduced from a 35/50 pen to a 10/20 pen. The different penetrations of F1 and F2 asphalt have some influence in the recycled mixture, once the asphalt stiffness of F1 asphalt is about 50% higher than one of F2 asphalt. The other characteristics are identical in both materials.

Table 1 – Characteristics of recovered asphalt of the reclaimed mixes

Recovered asphalt	Penetration (mm/10)	Softening point (°C)	Viscosity (cP)
F1	12	68	275
F2	18	65	313

The aggregate gradation of the reclaimed asphalt mixes, after extracting the asphalt, is presented in Figure 1 together with the gradation limits for the recycled asphalt rubber mix, which is a typical gap-graded asphalt rubber mix.

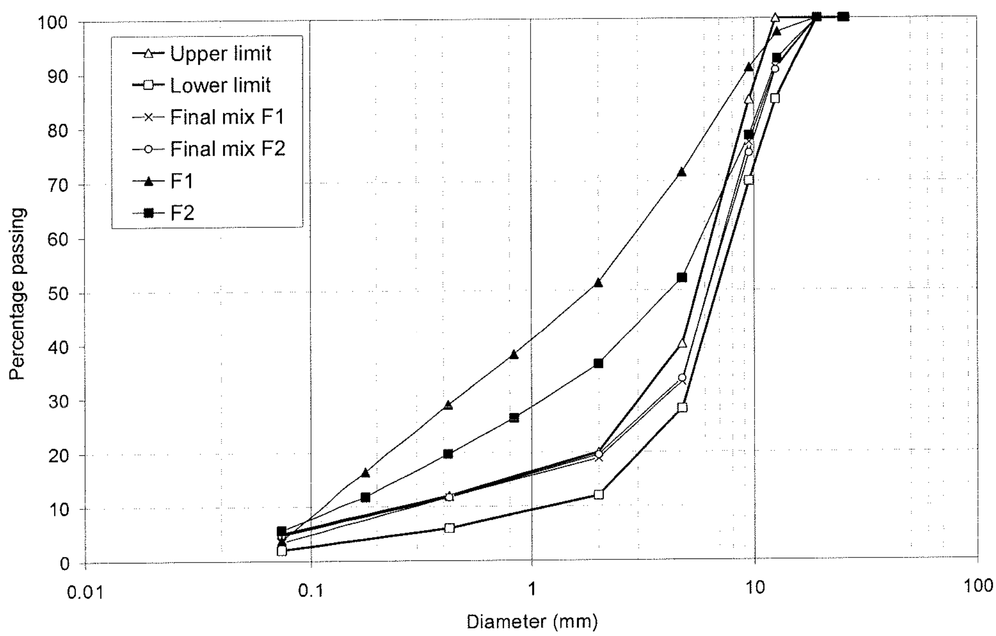

Figure 1 – Aggregate gradation of reclaimed mixes, recycled mix specification limits and final mix

The aggregate gradation curves for F1 and F2 reclaimed mixes exhibit a continuous gradation characterized by the presence of a significant amount of fine aggregates if compared to the gradation of the gap-graded mix used to produce the asphalt rubber mix of this work. F1 reclaimed mix presents more fines than mix F2, what will affect the design of recycled mixes.

The calculation of the recycling ratio, i.e. the amount of reclaimed material used in the production of the recycled mixture, allowed concluding that for F1 material the recycling ratio can reach 30% and for F2 material the recycling ratio can reach 45%.

Reclaimed asphalt mix F1 presented an asphalt content of 5.9% (in relation to the total weight of the mix) obtained by the ignition method, whereas the F2 material exhibited an asphalt content of 5.0%.

DESIGN OF THE ASPHALT RUBBER

The design of the asphalt rubbers to be applied when recycling the reclaimed mix considered two types of binders: a) 35/50 pen asphalt; b) 50/70 pen asphalt. These binders are the ones adopted in Portugal for the different temperature conditions in the country. Due to the climatic conditions the 35/50 pen asphalt is the principal binder used for all types of asphalt mixes applied in pavement construction and rehabilitation. The 50/70 pen asphalt is used for pavements in the coldest parts of the country.

The main characteristics of these binders (penetration, softening point and apparent viscosity) are presented in Table 2. The 35/50 pen asphalt used in this work exhibits a softer behaviour compared to the typical 35/50 pen asphalt as the penetration of the binder used is near the maximum limit of this property.

Table 2 – Characteristics of the new asphalt used in this work

Asphalt type	Penetration (mm/10)	Softening point (°C)	Viscosity (cP)
35/50	48	54	172
50/70	56	52	230

The crumb rubber from waste tyres used in this study was obtained through the cryogenic process. The rubber gradation was tested following the requirements of ASTM C136 and the Greenbook recommendations. The rubber used followed the ADOT requirements type B namely with a grain gradation between 0.18 and 0.6 mm.

In accordance with the materials defined above, eight types of asphalt rubber were produced, four for each asphalt type. For the 50/70 pen asphalt, the content of crumb rubber was 18, 20, 22 and 24%. For the 35/50 pen asphalt, the content of crumb rubber was 18, 19, 20 and 21%. The difference in the content of crumb rubber used in these two asphalts results from the fact that the 50/70 is softer than 35/50 pen asphalt. The softer binders can be mixed with more crumb rubber without increasing the viscosity of the asphalt rubber.

The different types of asphalt rubber were produced in laboratory at a temperature of 175 °C, a digestion time of 45 minutes and tested in relation to penetration, softening point, resilience and viscosity. The results of the design of the crumb rubber are shown in Table 3 and represented in Figure 2 where it is observable that the increase of crumb rubber reduces penetration: the more content of crumb rubber, the harder asphalt rubber becomes. The same conclusion may be drawn for viscosity and softening point. In terms of resilience, the increase of the content in crumb rubber produces a more elastic asphalt rubber.

As expected these two types of asphalt used to produce the asphalt rubber produce different final products. The main difference between them appears from the fact that 50/70 pen asphalt allows adding about 1% more crumb rubber than 35/50 pen asphalt.

The design of asphalt rubber intends to define the crumb rubber content necessary to produce asphalt rubber. The main reason for choosing crumb rubber is because of the viscosity of asphalt rubber, as it is important in order to ensure a correct mixing of the binder with the aggregates and a correct compaction of the final mix.

Table 3 – Asphalt rubber characteristics

Asphalt rubber	Asphalt type	Rubber content	Penetration (mm/10)	Softening point (°C)	Viscosity (cP)	Resilience (%)
A1	50/70	18%	22	67	2013	53
A2	50/70	20%	21	71	2758	58
A3	50/70	22%	20	73	4975	61
A4	50/70	24%	19	78	8537	64
B1	35/50	18%	22	69	2104	55
B2	35/50	19%	21	71	2705	56
B3	35/50	20%	19	73	3533	56
B4	35/50	21%	19	73	5229	59

The production of asphalt rubber mixes is mainly made by using the continuous blend process, in which asphalt rubber is produced near the asphalt mix plant with the help of specific equipment, and supplied to the asphalt mix plant in accordance with needs. To reach the asphalt mix plant, asphalt rubber needs to have a specific viscosity to be pumped appropriately. Present equipment can supply asphalt rubber with a viscosity inferior to 5000 cP.

Based on the obtained results, a content of 22% crumb rubber may be used to produce asphalt rubber with 50/70 pen asphalt, as it was used in this study (asphalt rubber A3). For the 35/50 pen asphalt, only 20% crumb rubber can be used (asphalt rubber B3).

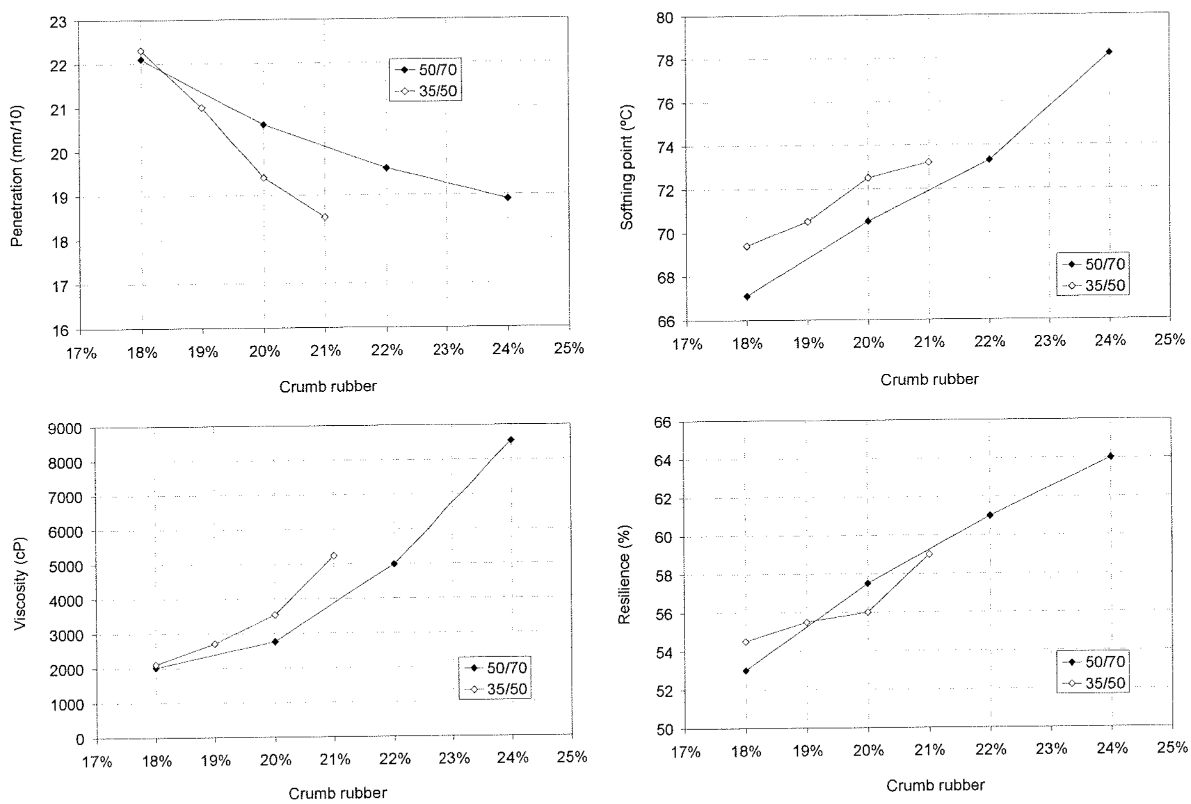

Figure 2 – Influence of crumb rubber content on the asphalt rubber characteristics

An analysis of Figure 2 allows the conclusion that the influence of the content in crumb rubber is more significant to values which are higher than 18%. From this value viscosity increases exponentially and no more than 3% to 5% of crumb rubber can be added. The influence of the content of crumb rubber on the other asphalt rubber characteristics follows a linear trend.

RECYCLED BINDER

The next phase of this work aimed at the evaluation of the characteristics of the binder resulting from the addition of asphalt rubber to the recovered asphalt from reclaimed mixes, simulating a recycling process. For this study both asphalt rubbers defined above (A3 and B3) were used together with the recycling ratios previously defined. For F1 material, which allows using up to 30% of reclaimed material, three recycling ratios were defined: 10, 20 and 30%. For F2 material, which allows using up to 45% of reclaimed material, 10, 25 and 40% recycling ratios were defined.

The results of this study (Table 4 and Figure 3) are related to the characteristics assessed for recycled binders, i.e. penetration, softening point, resilience and viscosity, as well as to the value of content in crumb rubber for recycled mixes. The results related to the characterization of the recycled binder allow the conclusion that the penetration exhibits a different trend depending on the reclaimed material. The increase of the ratio of F1 material produced a penetration decrease that was not expected. For the remaining characteristics, the increase of the recycling ratio produced a decrease in viscosity, softening point and resilience, as expected, as the asphalt rubber was modified by a conventional asphalt, in this case aged due to climatic conditions.

In practical terms, the recycled binder is a mix of recovered asphalt from a reclaimed mix in a percentage given by the recycling ratio and asphalt rubber. Thus, the characteristics of the recycled binder are a function of the characteristics of those two components. Relatively to penetration and softening point, this approach can be considered valid and the characteristics of the recycled binder can be calculated once the characteristics of the components are known. For viscosity, due to the digestion of the crumb rubber, mainly after mixing, the calculation is not valid. The calculated viscosity gives values 50% higher than the measured viscosity.

Table 4 – Recycled binder characteristics

Asphalt rubber Reclaimed Asphalt	Recycling ratio	Penetration (mm/10)	Softening point (°C)	Viscosity (cP)	Resilience (%)	Crumb rubber content (%)
A3 F1	10%	19	72	3484	53	19.8
	20%	18	72	2816	48	17.6
	30%	15	74	1430	47	15.4
B3 F1	10%	19	73	2512	49	18.0
	20%	18	72	1549	44	15.0
	30%	16	70	966	42	12.0
B3 F2	10%	22	76	2275	54	18.0
	25%	23	75	1354	50	15.0
	40%	24	70	800	44	12.0
A3 F2	10%	20	75	3525	56	19.8
	25%	21	73	1946	52	17.6
	40%	21	71	916	47	15.4

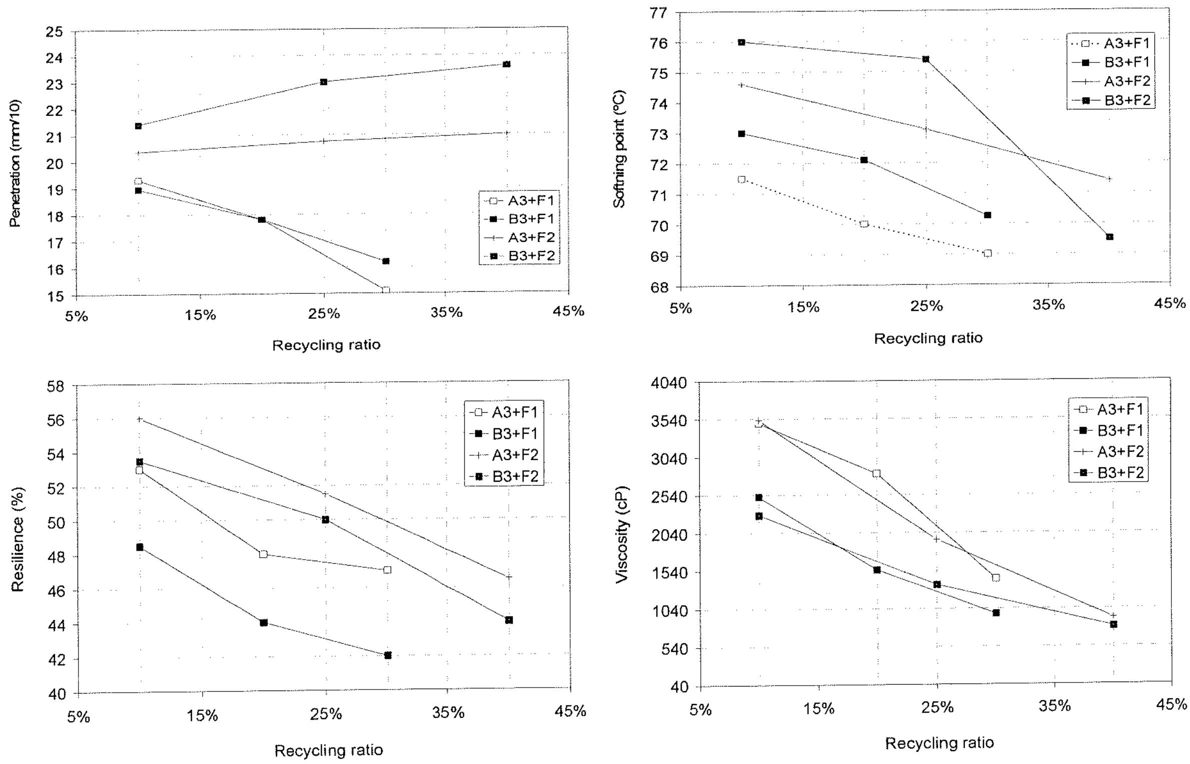

Figure 3 – Influence of recycling ratio on the recycled binder characteristics

The analysis of the influence of the recycling ratio, asphalt rubber and recovered asphalt on the recycled binder, expressed in Figure 3, allows the conclusion that any recycling ratio can be used to produce a recycled mix because the recycled binder presents characteristics which make possible the production of asphalt mixes. This can be mostly observed through viscosity. As the recycling ratio increases the recycled binder remains less modified by the crumb rubber and the expected performance of the recycled asphalt mixes will be reduced if compared with the performance of typical asphalt rubber mixes.

RECYCLED MIXTURES

The recycled mixture with 30% of F1 reclaimed material and B3 asphalt rubber, produced with the 35/50 per asphalt and 20% of crumb rubber, was characterized in terms of Marshall properties, stiffness modulus and fatigue resistance for 5 binder contents (8.5, 9.0, 9.5, 10.0 e 10.5%).

The Marshall test results expressed by the stability, flow, bulk density and void content are presented in Table 5. The Marshall stability as well as the bulk density are almost constant for all binder contents of the recycled mixes. The only variables which exhibit some variability with the binder content are the flow and the void content. Both variables present typical values for asphalt rubber mixes not allowing to define the binder content for the recycled mixture.

The test procedure for stiffness and fatigue resistance for all mixtures included placement of the specimens in an environmental chamber during 2 hours to reach the test temperature. The test configuration employed in this study was the four-point bending test in controlled strain. In controlled strain mode, the strain is kept constant and the stress decreases during the test.

Table 5 – Marshall test results

Binder content (%)	Marshall stability (kN)	Flow (mm)	Bulk density (g/cm3)	Void content (%)
8.5	8.1	4.2	2.25	5.0
9.0	8.4	5.4	2.26	3.8
9.5	8.4	4.4	2.25	3.8
10.0	8.3	3.7	2.24	3.6
10.5	8.3	5.5	2.25	3.2

The frequency sweep test was used to measure the stiffness and the phase angle of mixtures when subjected to different loading frequencies. In this study, seven frequencies were tested (10; 5; 2; 1; 0,5; 0,2; 0,1 Hz) in 100 cycles. The results of frequency sweep tests to determine the stiffness of the mixtures, conducted at 20 °C, are shown in Figure 4.

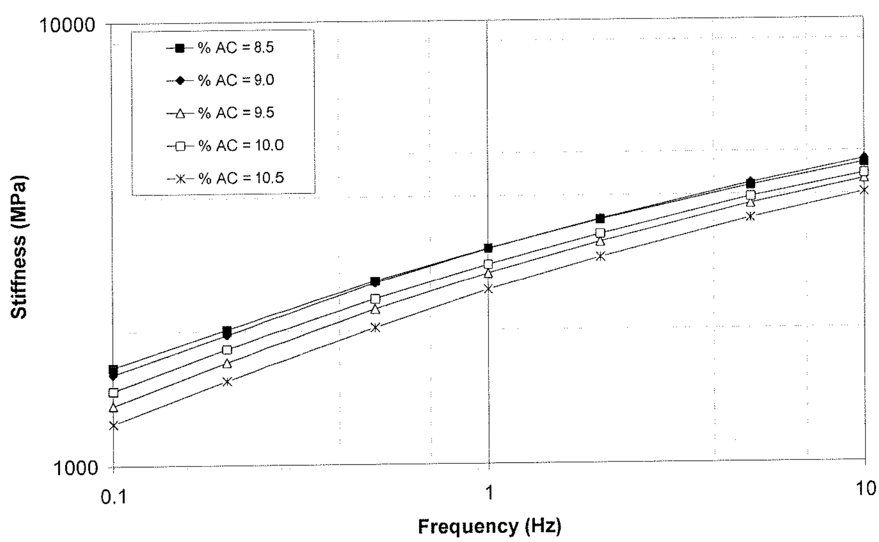

Figure 4 – Stiffness of recycled mixtures

The stiffness of the recycled mixes increases with the decrease of the binder content and exhibits the maximum value of 4700 MPa at 10 Hz for the mixture with 8.5% binder content. The mixture with 10% binder content has 4000 MPa at 10 Hz, which is only 20% less than the maximum obtained in this study.

Flexural fatigue tests were conducted according to the AASHTO TP 8-94 (Standard Test Method for Determining the Fatigue Life of Compacted HMA Subjected to Repeated Flexural Bending). All tests were carried out at 20 °C and at 10 Hz. The flexural beam device allows testing beam specimens up to dimensions of 50 mm by 63 mm by 380 mm. Fatigue failure was assumed to occur when the flexural stiffness reduces to 50 % the initial value. The fatigue tests were conducted in strain control applying 3 different strain levels (400×10^{-6}, 600×10^{-6} and 800×10^{-6}) and for each one 3 specimens were tested through a sinusoidal loading without rest periods.

The mixtures with 9.0%, 9.5% and 10.0% binder content were tested with only 2 strain levels. Despite this fact, the results presented a high precision, as illustrated in Figure 5.

The analysis of this figure allows the conclusion that, as expected, the increase of the binder content of the asphalt mixture increases the fatigue resistance. This fact allows that, in terms of design of the asphalt mixture, the binder content can be defined as a function of the expected traffic. However, this choice must also be based on the resistance to the permanent deformation of the asphalt mixtures to ensure that rutting does not occur for the design traffic.

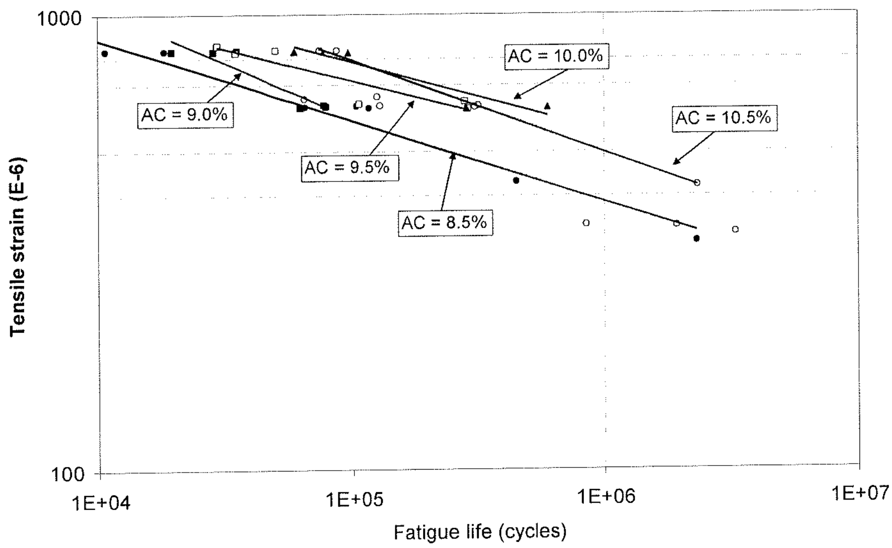

Figure 5 – Fatigue curves for the recycled mixtures

The fatigue test results expressed in terms of fatigue law (Equation 1) are presented in Table 6, as well as the N_{100} (fatigue life for a tensile strain of $100x10^{-6}$) and ε_6 (tensile strain for a fatigue life of $1x10^6$).

$$N = a * \left(\frac{1}{\varepsilon}\right)^b \qquad (1)$$

where: N = fatigue life;
ε = tensile strain (10^{-6});
a, b = coefficients.

Table 6 – Coefficients of the fatigue laws

Binder content (%)	a	b	R^2	N_{100}	ε_6
8.5	9.764E+19	5.419	0.966	1.42E+09	382
9.0	7.246E+14	3.574	0.865	5.16E+07	302
9.5	3.834E+22	6.163	0.859	1.81E+10	491
10.0	1.653E+22	5.940	0.895	2.18E+10	537
10.5	2.130E+19	4.941	0.998	2.79E+09	498

The fatigue resistance of the recycled mixtures was compared to the typical mixtures with asphalt rubber. Thus, it can be concluded that they have an identical performance as the typical asphalt rubber mixtures (Figure 6). Some differences can be found in this comparison due to the binder content. Nevertheless, it can be established that for an average binder content of 9.0-9.5%, the performance is identical, suggesting that recycling does not affect the fatigue performance.

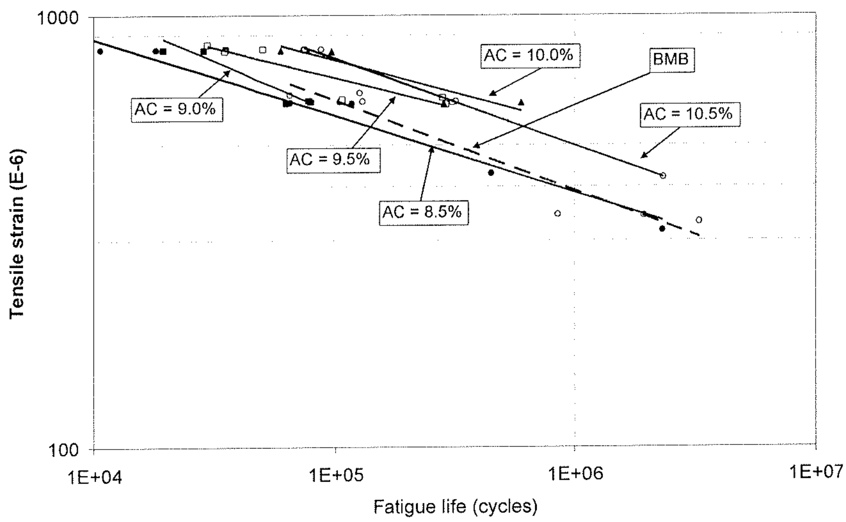

Figure 6 – Comparison between recycled mixtures and asphalt rubber mixture

CONCLUSION

This paper presented the results of a study carried out to determine recycling of a reclaimed asphalt mixture using as new binder an asphalt rubber. The study comprised learning about the reclaimed material, the design of the asphalt rubber, the prediction of the recycled binder properties and the fatigue performance of the recycled mixtures.

The design of asphalt rubber defines the crumb rubber content to be used to produce asphalt rubber. The values obtained, 22% of crumb rubber content for 50/70 pen asphalt and 20% crumb rubber for 35/50 pen asphalt, are the typical values for asphalt rubber. The 50/70 pen asphalt with more crumb rubber probably will be the best solution for recycling because it will have a better performance in recycled asphalt mixes.

The results of the characterization of the recycled binder allowed the conclusion that penetration can exhibit different trends depending on the reclaimed material as a result of the reduced recycling ratios.

The analysis of the fatigue results performed on the recycled mixtures allowed the conclusion that the increase of the binder content of the asphalt mixture increases the fatigue resistance and the fatigue resistance obtained for the recycled mixtures compares well with the typical mixtures with asphalt rubber.

REFERENCES

Pais, J., Pereira, P.A.A., Junior, J., Gardete, D. (2008). Physical properties of asphalt rubber after being mixed with reclaimed asphalt mixes, *First International Conference on Transportation Infrastructure*, Beijing, China.

PIARC (2003). Pavement recycling. Report of the PIARC Committee C7/8 – "Road Pavements", Paris.

Tia, M., Ruth, B. (2003). Recycling of asphalt rubber pavements. *Proceedings of the 2nd Asphalt rubber conference*, Brasilia, Brazil.