

Enrobée de qualité

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Les travaux de génie civil et en particulier la superstructure routière sont soumis à des normes spécifiques pour la mesure et l'évaluation des caractéristiques mécaniques. Ces normes sont conçues pour garantir à la même une durée de vie utile définie par l'entité adjudicatrice, qui est mesurée en années. La durée de vie utile du revêtement routier est fortement corrélée au type et au niveau de trafic (charge sur la structure de la route), à la fréquence d'application, à la température de fonctionnement, aux caractéristiques des matériaux utilisés, etc..

A cet égard, différentes technologies innovantes ont été introduites sur le marché (par exemple PMB - PolymerModifiedBitumen et PMA - PolymerModifiedAsphalt), qui agissent sur le facteur caractéristiques des matériaux. En effet, en augmentant les performances mécaniques du conglomérat bitumineux, il est possible de créer des sols pouvant garantir une meilleure réponse à des facteurs externes tels que les charges appliquées, les températures, etc.

A charge de l'entrepreneur il y a toutes les conditions requises pour empêcher l'apparition de dommages aux travaux, l'environnement, les gens et les choses dans l'exécution du contrat et conformément aux spécifications du cahier de charge établie sur la base de l'appel d'offres du projet. L'exécution de tous les travaux, oeuvres et composants doivent respecter les dispositions légales et réglementaires sur la qualité, la provenance et l'acceptation des matériaux.

Avant la pose, les matériaux doivent être reconnus comme appropriés et acceptés par la direction des travaux, également après des tests de laboratoire spécifiques et / ou des certifications, également à effectuer à la demande de la direction des travaux et fourni par le producteur. Après la pose, la direction des travaux pourra organiser les contrôles techniques et les tests de laboratoire requis par la réglementation en vigueur pour l'acceptation des travaux effectués. En l'absence de dispositions précises concernant les exigences de qualité

des matériaux, la direction des travaux a le droit d'appliquer des normes particulières, lorsqu'elles existent, nationales ou étrangères.

Afin de garantir la qualité du conglomérat bitumineux, les principales phases de contrôle sont:

- préliminaire, qui prend la forme de tests de laboratoire visant à vérifier l'adéquation des matières premières avec l'acceptation des matériaux. Au cours de cette phase, la conception du mélange et les caractéristiques du mélange sont définies: recette et caractéristiques volumétriques et mécaniques. Les principaux tests effectués pour valider le mélange sont les suivantes: conception du mélange (mix-design), la Job Mix Formule (JMF), l'essai Marshall à 60°C, la résistance à la traction indirecte à 25°C, l'essai de module de résilience à différentes températures et fréquences, la résistance au orniérage à 50-60°C, l'essai de fatigue à 25°C;

- pendant la construction, qui prend la forme avec contrôles en phase de construction par des contrôles périodiques des matières premières (granulats, bitume, etc..) et des contrôles sur le produit fini généralement pris lors de la pose et visant à valider les résultats et les caractéristiques obtenues dans la phase préliminaire;
- fin du travail, qui prend la forme de tests statiques et dynamiques en laboratoire ou in situ, en fonction des spécifiques requises par la direction de travaux et / ou par les normes, afin de contrôler la bonne exécution des travaux, afin d'assurer la durée de vie prévu.

Les principaux tests réalisés in situ sont:

- la collecte des carottes à analyser: épaisseur du revêtement, courbe granulométrique, dosage du bitume et analyse des vides;
- analyse par FWD poudre de Benkelman;

L'absence des exigences sur les carottes et les essais sur place, conformément à la réglementation en vigueur, exige l'entrepreneur pour la démolition et la reconstruction, à ses frais, des travaux que le Directeur de Travaux juge non réalisée de façon professionnelle (dans le cas d'un pavage en conglomerat bitumineux, un paramètre discriminant peut être la teneur des vides de la chaussée qui ne respecte pas les limites d'acceptabilité). Les défauts et les vices du travail, constatés par le Directeur des Travaux, doivent être résolus par l'entrepreneur du fait de la non-inclusion dans les comptes du relatif correlative.

Par exemple, pour justifier ce qui précède, quelques extraits d'un Cahier des Charges Techniques de l'Organisme Concessionnaire Italien MilanoSerravalle-MilanoTangenziali (MSMT), qui gère un réseau d'infrastructures qui est le pivot de l'un des principaux réseaux européens, sont rapportés ci-dessous:

- A7 Autoroute Serravalle Milano (dés Milano Piazza Maggi àSerravalleScrvia) 86,3 km;
- A50 AutorouteTangenzialeOvest de Milano avec connexion Fiera Rho-Pero 33,0 km;
- A51 Autoroute Tangenziale Est de Milano 29,4 km;
- A52 Autoroute Tangenziale Nord de Milano 12,9 km;
- A53 RaccordBeregardo-Pavia 9,1 km;
- A54 Autoroute Tangenziale dePavia 8,4 km;

The image shows a technical specification document for road maintenance work. At the top, it features the logos of 'MilanoSerravalle' and 'MilanoTangenziali' on the left, and the company name 'Milano Serravalle - Milano Tangenziali S.p.A.' with its address on the right. The main title is 'Area Manutenzione Opere Stradali e Civili'. Below this, it states 'Ministero delle Infrastrutture e dei Trasporti' and 'CONVENZIONE UNICA STIPULATA IL 07/11/2007' with 'REDA ESECUTIVA CON LEGGE 10/10/08'. The specific work is described as 'Lavori di manutenzione delle pavimentazioni stradali' with the location 'TRATTE: AUTOSTRADA A50 TANGENZIALE OVEST DI MILANO E PERTINENZE' and the contract number 'CIG: 6583711A2E'. It is identified as 'GARA LAVORI OSC 03/2016' and 'Capitolato Speciale d'Appalto SPECIFICHE TECNICHE'. A table at the bottom records the date of the work (11/05/2016), the contract number (OSC N° 03/16), the road type (A50), the technical part (FEBRO), and the approving director (COLOMBO). The document is signed and dated at the bottom right.

Considérant une couche de connexion avec hautes performances entre la couche d'usure et la base, le MSMT prévoit l'utilisation de:

ART. 7 – HIGH PERFORMANCE BINDER COURSE IN ASPHALT CONCRETE WITH NEAT BITUMEN AND ADDITION OF POLYMERS

The layer of high performance Binder in bituminous mix with neat bitumen, and addition of polymers, is constituted by a granular mixture, mainly of crushed, composed of a mixture of coarse and fine aggregate and filler (according to the definitions in the standard UNI EN 13043 "Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas"), hot-produced with semisolid bitumen for road use (with definition and requirements according to UNI EN 12591 "bitumen and bituminous binders - Specifications for bitumen for road applications ") after preheating the aggregates. The addition of the polymers takes place directly into the mixer during the production. The product is laid by vibratory finishing machine and compacted with metal vibrating rollers.

The mixture can also include aggregates arising from the demolition of pavements at the end of useful life, provided that it is tested according to current standards and to the requirements of UNI EN 13108-8 "Bituminous mixtures: Material specifications - recovery of Bituminous mix."

To be eligible and used, the asphalt concrete must be equipped with mandatory CE marking. The mandatory requirements are:

- Mixture temperature at production;
- Binder minimum content;
- Grading composition;
- Voids content.

The binder has the function of linking the wearing layer to the base one, transmitting the vertical action of the loads and absorbing part of the bending actions without permanent deformation.

The thickness of the binder layer is determined during the design phase, unless otherwise specified by the Project Director (PD).

All the studies of the mixtures regarding works reported in the Contract Technical Specifications carried out by the contracting companies, must be submitted to the Project Director well in advance of the beginning of the work and approved by the PD. Their acknowledge does not however relieve the Company from the responsibility of obtaining the prescribed final performance results.

Ce conglomerat bitumineux est produit avec la technologie PMA conformément à la législation européenne concernant le marquage CE (UNI EN 13108).

Les tests préliminaires identifiés sont réalisés sur les matières premières suivantes:

1. Bitume :

7.1.1 Binder

The bitumen for road use have to be CE marked showing compliance with Appendix ZA of UNI EN 12591 "Bitumen and bituminous binders - Specifications for bitumen for road applications" with reference to additional information for the semisolid bitumen 50-70 or 70-100, contained in the document UNI/TR 11361 "Bitumen and bituminous binders - Bitumen for road applications mainly used in Italy".

Neat bitumen			Limits (UNI EN 12591)	
Parameter	Standard	UM	Class 50/70	Class 70/100
Penetration at 25°C	UNI EN 1426	0,1 mm	50-70	70-100
Softening point	UNI EN1427	°C	46 - 54	43-51
Breaking point (Fraass)	UNI EN 12593	°C	≤ - 8	≤ - 10
Dynamic viscosity at 160°C	UNI EN 13302	Pa*s	0,03-0,10	0,02-0,10
Values after RTFOT		UNI EN12607-1		
Residual penetration	UNI EN 1426	%	50	46
Increase of the softening point	UNI EN1427	°C	≤ 11	≤ 11

2. Agrégats grands :

Coarse aggregate

The coarse aggregate (fraction of dimension higher/equal to 2 mm) may also have rounded elements and/or partially crushed and must meet the following requirements:

Coarse aggregate			
Parameter	Standard	UM	Limit (UNI EN 13043)
Resistance to fragmentation (Los Angeles)	UNI EN 1097-2	%	≤ 25 (LA ₂₅)
Crushed surfaces	UNI EN 13043	---	C _{99/1}
Resistance to frost/defrost	UNI EN 1367-1	%	≤ 1 (F ₁)
Affinity bitumen-aggregate (Stripping)	UNI EN 12697-11	%	≤ 5
Shape coefficient	UNI EN 933-4	---	≤ 20 (SI ₂₀)
Flattening coefficient	UNI EN 933-3	---	≤ 15 (FI ₁₅)
Fine content	UNI EN 933-1	%	≤ 0,5 (f _{0,5})

In any case, even if of a different nature, the coarse aggregate will have to be constituted by healthy, hard, durable, versatile, clean elements free from dust and extraneous or pollutants materials.

3. Agrégats fins :

Fine aggregate

The fine aggregate (fractions smaller than 2 mm) shall be composed of crushed and/or natural sands and shall meet the following requirements:

Fine aggregate			
Parameter	Standard	UM	Limit (UNI EN 13043)
Equivalent in sand	UNI EN 933-8	%	≥ 60 (SE ₆₀)
Fine content	UNI EN 933-1	%	≤ 10

4. Filler d'addition :

7.1.3 Added filler

In addition to that coming from the fine fractions of aggregates, any additional filler shall come from the grinding of limestone or shall be made of cement or hydraulic lime. However, they must meet the following requirements:

Added filler			
Parameter	Standard	UM	Limit (UNI EN 13043)
Passing at sieve UNI 2 mm	UNI EN 933-10	%	100
Passing at sieve UNI 0,125 mm	UNI EN 933-10	%	85÷100
Passing at sieve UNI 0,063 mm	UNI EN 933-10	%	70÷100
Plasticity Index	UNI CEN ISO/TS 17892-12		N.P.
Stiffening Power Filler/bitumen ratio = 1,5	UNI EN 13179-1	Δ _{0,075}	8÷25 (Δ _{0,075} 8/25)

5. Matériel de recyclage (RAP) :

7.1.4 Recycled mix

The recycled bituminous mix (RAP) derives from the demolition of pavements at the end of their useful life both through demolition and subsequent crushing, both with milling machines directly in situ. The classification of the material has to be performed according to the UNI EN 13133-3.

The percentage by weight of recycled material referred to the total of the aggregates mixture must be at most equal to 30%.

For the binder layer, RAP coming from base, binder and wearing layers can be recycled. The percentage of RAP to be used must be notified in the preliminary mix study that the company is required to submit to the PD before the beginning of the works.

Afin de qualifier et d'indiquer les quantités minimales pour les produits d'addition, les essais préliminaires suivants sont également effectués:

- Promoteurs d'adhésion dans le cas où il est nécessaire d'augmenter ou de garantir l'adhérence agrégat-bitume :

7.2.1 Antistripping agents

The antistripping agents are special additives, whose main function is to increase, or even create, the affinity between bitumen and aggregate. This action should ensure a bond as stable as possible in any condition of application. The additives should, therefore, prevent the stripping of the binder from the aggregates.

The antistripping agent must be chosen in function of the chemical nature of the aggregate used for the production of the bituminous mixture. Therefore, the additive may be amine based, polyphosphoric or of any other nature, provided that they meet the limit of affinity bitumen-aggregate provided above for the coarse aggregate, according to the UNI EN 12697-11.

The dosage of these products will vary, generally, from 0.30% to 0.60% on the bitumen weight, depending on the lithological nature of the aggregate and the operating conditions (temperature, type of mixture to be produced, etc.). The addition of the additives in bituminous binder must be made with suitable equipment, to ensure the exact dosage and the perfect dispersion in the bitumen.

- Régénérants si est utilisé du matériel de recyclage (RAP) :

7.2.2 Functional chemical antistripping

The functional chemical antistripping (ACF) are used to rejuvenate the characteristics of aged bitumen contained in the bituminous mix to be recycled. The ACF must be liquid multifunctional additives with high rejuvenating power, free from the presence of aromatic oils and a with a low odor impact.

The regenerating must have the physical-chemical characteristics reported in the following table:

Chemical Functional Antistripping			
Parameter	Standard	UM	Value
Aspect	---	---	Liquid
Apparent density at 20°C	---	g/cm ³	0,91±0,02
Viscosity at 25°C	EN 20028	cP	60 ± 10
Flash point	EN 2592	°C	≥ 150
Pour Point	EN 20065	≤	0°C

The dosage should be equal to 0.1 to 0.5% on the weight of the RAP and any changes in such amounts must be appropriately demonstrated and justified with proper documentation to PD.

The introduction of the ACF in the bitumen must be made with suitable equipment in the storage tanks or in-line during the production cycle. These dosing devices must ensure the exact dosage and their perfect dispersion in the asphalt binder.

8. Polymères d'addition pour la technologie PMA :

7.2.3 Added Polymers

The modification of the bituminous mix with polymers causes the increase of the mechanical strength and of the complex modulus, the decrease of the accumulation of the deformation to the repetition of loads, resulting in an improvement of the fatigue behavior, of the traditional mixture produced with normal bitumen.

The higher performances of the bituminous mix will be obtained by the modification of the mixture with a compound composed of selected polymers with low molecular weight and average melting point in semi-soft and flexible granules.

Polymers for the modification of bituminous mixtures			
Parameter	Standard	UM	Limit
Composition			Plastomeric compound
Aspect			Granules of homogeneous shape
Color			Monochrome from gray to black
Odor			Barely perceptible
Dimension of the granules		mm	3,0-5,0
Melt Index at 190 °C with weight of 2,16 kg	ISO 1133-1:2011	g/10'	2-4
Ashes at 500 °C	UNI ISO 3451-1	%	≤ 3
On neat bitumen and 6% of polymer at 5 °C, Increase of the complex modulus with DSR, at frequency 10 Hz and strain 0,1%.	UNI EN 14770	%	50-60
On neat bitumen and 6% of polymer at 5°C, reduction of the phase angle with DSR, at frequency 13 Hz and strain 0,1%.	UNI EN 14770	%	25-35
On neat bitumen and 6% of polymer at 40°C, increase of the complex modulus with DSR, at frequency 10 Hz and strain 0,1%.	UNI EN 14770	%	65-75
On neat bitumen and 6% of polymer at 40°C, reduction of the phase angle with DSR, at frequency 10 Hz and strain 0,1%.	UNI EN 14770	%	20-30

In addition, test reports of production control for each production batch shall be provided to the PD. The supplier company must have ISO 9001, ISO 14001, and at least 10 years of references on this product.

The dosage of the product must vary according to the modification to be made and to the mechanical performances to be achieved:

- Moderate addition of additives = 2 – 4 % on total bitumen weight;
- High addition of additives = 4 – 6 % on total bitumen weight.

The polymer must be added directly in the mixer of the production plant through a dosing system ensuring the homogeneity of the final product.

The introduction of the product inside the mixer must take place after unloading of the aggregates and before the bitumen, which should be introduced with a delay of about 10 seconds, to ensure the homogeneity and the dispersion.

Toujours selon la norme UNI EN, le MSMT fournit soit la courbe granulométrique de référence soit la méthode à suivre pour déterminer le pourcentage optimal des différents composants (agrégats, bitume et additifs):

7.3 MIXTURES

The mixture of stone aggregates of first use and RAP shall have a certain particle size composition in accordance with UNI EN 13108-1 and UNI EN 12697-2, using the sieves belonging to base group + 2, and must be within the following limits of the grading curve:

Grading curve			Bitumen content on mixture [%] (UNI EN 13108-1)
Sieves series UNI EN	Minimum passing [%]	Maximum passing [%]	
20	100	100	≥ 4,20 (B _{min,2})
16	90	100	
14	75	95	
12,5	65	85	
10	60	78	
8	52	70	
6,3	45	65	
4	35	55	
2	25	40	
1	18	30	
0,5	10	23	
0,25	6	15	
0,063	4	10	

The total percentage of binder (including the bitumen present in the RAP), referred to the weight of the mixture must

compresa nei limiti indicati nella tabella precedente.

La quantità ottima di bitume totale deve essere determinata mediante metodo Marshall (con riferimento alla Stabilità e con provini costipati con 75 colpi di maglio per lato) e, a tale percentuale ottimale, si dovranno rispettare i seguenti requisiti determinati con metodo volumetrico:

Condizioni di prova (UNI EN 12697-31/13108-20)	Unità di misura	Limiti (UNI EN 13108-1)
Angolo di rotazione	°	1,25 ± 0,02
Velocità di rotazione	Giri/min	30
Pressione verticale	kPa	600 ± 3
Diametro del provino	mm	150
Rotazioni N1	---	10
Rotazioni N2	---	120
Rotazioni N3	---	200

Il est évident qu'il est également essentiel de fournir la performance du mélange bitumineux et donc aussi bien les tests à effectuer que les résultats permis:

The optimal mixture shall have the following characteristics after compaction at N3:

Results requested	UM	Limits (UNI EN 13108-1)	
		Type of addition of additives	
		Moderate	High
Bitumen-aggregate affinity- Stripping (UNI EN 12597-11)	%	≤ 5	
Voids at N1 (UNI EN 12697-8)	%	≤ 14 (V_{voids})	
Voids at N2 (UNI EN 12597-8)	%	3+5 (V_{voids})	
Voids at N3 (UNI EN 12697-8)	%	≥ 2 (V_{voids})	
Resistance at indirect tensile strength at 25°C (UNI EN 12697-23)	N/mm ²	1,00±2,00	1,20±2,20
Coefficient of indirect tensile strength at 25°C (UNI EN 12697-23)	N/mm ²	60 - 250	60 - 250
Loss of resistance to indirect tensile strength at 25°C (UNI EN 12697-12)	%	≥ 90 (ITS ₉₀)	≥ 90 (ITS ₉₀)
Stiffness (UNI EN 12697-26 – Annexo C)			
T=5°C, Def.=7µm, Freq.=2Hz, Coeff.P.=0.35	MPa	15.000-25.000	18.000-27.000
T=20°C, Def.=7µm, Freq.=2Hz, Coeff.P.=0.35	MPa	6.000-13.000	8.000-15.000
T=40°C, Def.=7µm, Freq.=2Hz, Coeff.P.=0.35	MPa	300-5.000	900-6.000

Identifié le mélange optimale avec les tests de laboratoire, il est essentiel d'indiquer le processus de production et les méthodes d'application, pour obtenir les meilleures performances:

7.4 MIXTURE PACKAGING

The bituminous mix should be packed using automated fixed plants with suitable characteristics, always kept in perfect working order.

The production of each plant should not be pushed beyond its potential to ensure proper drying, homogeneous heating of the mixture and a perfect screening that ensures an appropriate reclassification of individual classes of aggregates. Continuous plants (drum- mixer type) can also be used provided that the dosage of components is performed by weight, with suitable equipment whose efficiency must be constantly monitored.

The plant must however ensure uniformity of production and be able to realize mixtures which match those listed in the study presented for acceptance.

Each plant must ensure the heating of the bitumen at the required temperature, in addition to the perfect dosage of all the raw materials used.

The storage area of the aggregates must be previously and conveniently arranged to avoid the presence of clay substances and puddles that can compromise the cleanliness of the aggregates. Furthermore, the heaps of the different classes must be clearly separated among them and the fueling operation of the pre-batchers must be performed with the utmost care. The mixing time should be determined according to the characteristics of the plant, to allow a complete and uniform coating of the aggregates with the binder.

The humidity of the aggregates at the exit of the dryer must not exceed 0.25% in weight.

The temperature of the aggregates at the time of mixing should be between 160°C and 180°C and that of the binder between 150°C and 170°C, in relation to the type of bitumen used.

For the verification of these temperatures, the dryers, boilers and hoppers of the plants must be equipped with fixed thermometers fully functional and regularly calibrated.

7.6 MIXTURE LAYING

The laying of asphalt concrete will be carried out through vibratory finishing machines in perfect efficiency and equipped with automatic self-leveling.

The pavers shall anyway leave a perfectly shaped finished layer, free of ginning, cracks and defects due to segregation of the larger stone elements.

In the laying, maximum attention shall be paid to the formation of longitudinal cracks preferably obtained through timely laying a strip next to the previous one.

If this is not possible, the edge of the strip already made must be sprayed with a cationic bitumen emulsion to ensure the welding to the next strip.

If the edge is damaged or rounded, it will be necessary to cut it vertically with suitable equipment.

The cross joints deriving from daily breaks must be always made after cutting out and removal of the last part of the reset terminal.

The overlapping of the longitudinal joints among the different layers shall be planned and realized so that they are staggered between them of at least 20 cm and they do not ever fall in correspondence of the two bands of the lane normally affected by the wheels of the heavy vehicles.

The transport of the asphalt concrete from the production plant to the paving site shall be carried out by means of transport of adequate capacity, efficient and fast. However, always covered to prevent excessive surface cooling and the formation of crusts.

The temperature of the asphalt concrete at the time of paving, controlled immediately behind the paver, shall be at all times equal to 150-170°C.

The mix laying shall be stopped when the general weather conditions may affect the success of the work.

The compromise layers must be immediately removed and then reconstructed at Company's expenses.

The compaction of the asphalt concrete shall start immediately after they are laid by the paver and carried out without interruption.

For the binder layers, combined rollers and/or all-iron vibrating rollers, of suitable weight and advanced technological features, should be used in order to ensure the achievement of the maximum obtainable density.

Moreover compaction shall be performed with the most appropriate methodology for obtaining even densification in every point, and prevent cracking and shearing in the layer just laid.

The surface of the layers must be, after compaction, free of irregularities and undulations. A 4-m long straight rod placed in any direction on the finished surface shall adhere to it uniformly; a maximum deviation of 3 mm can be tolerated.

The bituminous mixture of the binder layer will be laid after the PD has verified the compliance of the foundation to the requirements of height, shape, density and capacity specified in the project.

In the case of double layer laying, between the two stretches, a bitumen emulsion tack coat must be interposed to prepare the laying surface of the second layer.

Pour garantir la vie utile du revêtement de sol, il est essentiel la collaboration entre les différentes couches, ce qui est garanti par l'utilisation des émulsions bitumineuses par main d'attaque. Ces matériaux doivent également avoir certaines performances et sont donc soumis à des contrôles spécifiques:

7.5 PREPARATION OF THE LAYING SURFACES

Before the realization of a layer of asphalt concrete it is necessary to prepare the laying surface in order to ensure an adequate adhesion between the overlapped layers. The preparation should be performed through the application of modified bitumen (usable in any situation) or modified bitumen emulsions (usable in any situation with the exclusion of decks). Products must have the following characteristics:

Tack coat – Modified bitumen			Limits and classes (UNI EN 14023)
Parameter	Standard	UM	
Penetration at 25°C	UNI EN 1426	0,1 mm	45-80 (class 4)
Softening point	UNI EN1427	°C	≥ 70 (class 4)
Breaking point (Fraass)	UNI EN 12593	°C	≤ - 12 (class 6)
Dynamic viscosity at 160°C	UNI EN 13302	Pa.s	0,20-0,60
Elastic recovery at 25°C, 50 mm/min	UNI EN 13398	%	≥ 80 (class 2)
Storage stability, 3 days at 180 °C – variation of the softening point	UNI EN 13399	°C	≤ 3 (class 2)
Values after RTFOT			
Residual penetration at 25°C	UNI EN 1426	%	≥ 40 (class 3)
Increase of the softening point	UNI EN1427	°C	≤ 5 (class 2)
Mass variation	UNI EN 12607 - 1	%	≤ 0,3 (class 2)

Tack coat – Cationic emulsion 60% modified			
Quality indicator	Standard	UM	Limits (UNI EN 13808)
Polarity	UNI EN 1430	---	Positive (Class 2)
Water content compared to weight	UNI EN 1428	%	40±2 (Class 6)
Bitumen content + flux oil	UNI EN 1431	%	60±2 (Class 6)
Flux oil	UNI EN 1431	%	≤ 2 (Class 2)
Settling at 7 days	UNI EN 12847	%	≤ 10 (Class 3)
Breaking index	UNI EN 13075-1	---	70-155 (Class 3)
Bituminous residue			
Penetration at 25 °C	UNI EN 1426	dmm	≤ 100 (Class 3)
Softening point	UNI EN 1427	°C	≥ 60 (Class 2)
Cohesion energy with ductilometer at 5 °C	UNI EN 13589	J/cm ²	≥ 3 (Class 2)
Elastic recovery at 25°C	UNI EN 13398	%	≥ 50 (Class 5)

The dosage should be such that the residual bitumen is equal to 0.50-0.70 kg/m².

Pendant la phase de production, il est essentiel de vérifier que le mélange correspond et à la performance de ce qui a été identifié dans le laboratoire (conception du mélange), en recueillant l'enrobé chaud derrière le finisseur. Enfin, après la pose il est nécessaire de vérifier que, par l'enlèvement des carottes, le compactage a été effectué correctement et que les épaisseurs correspondent aux dispositions du projet.

7.8 ACCEPTANCE OF THE MIXTURES

Well in advance of the beginning of the work and for each production site, the company is required to submit to the Project Director the mixture composition to be used. Each composition proposed must be accompanied by full documentation of the studies performed and the CE marking of the raw materials used.

Sample	Withdraw site	Tests frequency	Requirements to be checked
Coarse aggregate	Plant	Daily or every 2500 m ³ of laying	According to previous reference table
Fine aggregate	Plant	Daily or every 2500 m ³ of laying	According to previous reference table
Filler	Plant	Daily or every 2500 m ³ of laying	According to previous reference table
Bitumen	Tank	Daily or every 2500 m ³ of laying	According to previous reference table
Additives	Containers	Daily or every 2500 m ³ of laying	According to previous reference table
Bulk asphalt concrete	Paver	Daily or every 5000 m ³ of laying	Characteristics resulting from the study of the mixture* and according to the previous reference table
Cores	Pavement	Every 500 m of laying strip	Thickness provided for in project
Cores	Pavement	Every 1000 m of laying strip	Bitumen and voids content according to prequalification ($\geq 98\%$) and according to previous reference chart
Pavement	Surface	In continuous with high efficiency	IRI $\leq 2,5$ (mm/m)
<p>* 1. Grading curve: compared with the pre-qualification, the following deviations are allowed:</p> <ul style="list-style-type: none"> - Coarse aggregate = $\pm 3\%$; - Fine aggregate = $\pm 2\%$; - Passing to sieve UNI 0,063 mm = $\pm 1,5\%$. <p>2. Bitumen percentage: compared to the pre-qualification, a $\pm 0,25\%$ of deviation is allowed.</p>			

Once the proposed mixture study is accepted by the Project Director, the company must follow it strictly. The quality control of the bituminous mix and of its laying will be made through laboratory tests on the constituent materials, on the mixture, on the cores extracted from the pavement and with in situ tests.

The location of the sampling withdraw and the frequency of the tests are shown in the table above. In every working site a suitably equipped laboratory for tests and checks during production must be installed and conducted at Company's expense, or the Company shall make available a mobile laboratory. Each sample must consist of two samples; a sample will be used for control, the other will remain available for any inquiries and/or subsequent scrutineering.