105

NEW VERSATILE BITUMEN EMULSIFIER FOR COLD MIX APPLICATION: FROM LABORATORY CONCEPTION TO FIELD TRIAL VALIDATION

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Arkema

Abstract:

During last we worked to develop new surfactant technology for bitumen emulsion. Based on renewable raw materials, this new emulsifier allows to produce emulsions with outstanding coating/workability properties, particularly suited for cold mix applications. Purpose of this article is to follow the project from the scope of work to the field trial on a rural country road going through all steps from laboratory to industrial production. The scope of work was quite challenging with many specifications, technical expectations: Renewable raw materials Easy to handle emulsifier Versatile non-hazardous emulsion Fully coated and easy to handle cold mixes with any type of aggregates and bitumen Pavement good mechanical properties, moisture resistance Compatible with high RAP use. First generation developed using standard laboratory mix-design process showed some unacceptable weaknesses when applied at industrial scale. Industrial emulsion showed some creaming issues not observed at laboratory scale and stripping occurred on the mix when too much energy was applied during paving step. After this disappointing attempt, we had to reconsider all steps from laboratory formulation to final paving application with objective to make our evaluation process more representative of the critical parameters encountered. Observations made during the first industrial implementation were key element to build-up the new evaluation process including more stringent tests at every step of the process. Based on this experience, new formulation was developed step by step (synthesis, formulation, emulsion manufacturing, cold mix production, mix properties) and validated at each scale (laboratory, pilot, industrial). The outcome of this exciting project is a patented new surfactant recently commercialized. In this presentation, we propose to present the story of this new surfactant development from the market request to the successful jobsite with a focus on the importance of field trials in the innovation process for chemicals used in paving applications.

130

High performance termosetting emulsions

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Abstract:

Correct tack coating is extremely important, not only in order to seal the existing surface against the entry of water and, but also to bond the wearing course to the base course. Inadequate bonding between layers can result in detachment, followed by longitudinal wheel path cracking, potholes and other distresses, such as rutting that greatly reduce the life of the pavement. The use of conventional emulsions for tack coats can cause problems as they frequently stick to the tires of construction vehicles. Consequently, the bond between the asphalt layers is inadequate. The emulsions usually used for tack coats usually causes problems in the application, since it residual binder have a low consistency that frequently adhere to the tires of the work vehicles and, in consequence, the adherence between the layers of asphalt is reduced. To respond to the need for improvement of these products, for years new types of emulsions (thermo-adherent), made from hard bitumen, have been developed. These emulsions have low tackiness and are therefore resistant to traffic. However, there are still some application conditions, linked to the high summer temperatures, in which even thermoadherents emulsions, have limitations. In this work, the results of the development of high-performance thermosetting emulsions that solve the problems presented by the usual products, with extreme weather conditions, are presented. The advantages are a high adherence to the surface of the pavement and no adhesion to tires, on-site cleaning, fast breakage and greater efficiency even with lower dosage. In order to verify its best performance, results of comparative tests with conventional tack coat emulsions and with normal thermoadherents will be presented

131

High performance recycling with bituminous emulsions

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Abstract:

The structural rehabilitation of asphalt pavements using techniques such as recycling with emulsion is framed on the principles of the Circular Economy and therefore its use should be strengthened in comparison with other options. This technique has clear environmental and economic advantages as the saving of a significant percentage of quality aggregates, since a good part of the asphalt mixes to be recycled generally come from the milling of the top layers, and the decrease of the dosage of binder, based on to the regeneration that can be obtained from the aged binder existing in the pavement to be recycled, thanks to the contribution of a specific bituminous emulsion. Despite these advantages, one of the disadvantages that have limited its use is that cold recycled mixtures with emulsion, require a curing period to remove the water from the mixture and achieve the final mechanical properties. This drawback is avoided with the half-warm recycling but even so, in the current regulations, there are limitations that prevent its use for new surface layers. The objective must be to ensure that the final performances of the half-warm recycling are similar to those of the AC type bituminous mixtures that would be put in place, in the case of milling and replacement with hot mixes. This paper presents the development of high performance modified emulsions, suitable for use in emulsion half-warm recycling that can satisfy the requirements demanded to the surface layers, at least for low trafficked roads surfaces. The improvements to be achieved will not only allow the economic and environmental benefit of the recycled ones, but also an improvement in the performance of the mixture and in its durability, thanks to the use of half-warm recycling techniques and high performance emulsions.

142

European laboratory test methods for slurry surfacing revised in view of field practice

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Abstract:

Slurry surfacing is a maintenance technique frequently used in Belgium on low volume roads. The road surface is thereby restored, while protecting the underlying structure against water infiltration and deterioration. However, there is still a huge potential for this technique, even on higher volume roads, provided that slurry mixtures are properly formulated in view of traffic and climate, but also in view of the expected weather conditions during laying. Since it is a cold bituminous emulsion mixture, workability, curing and performance after opening to traffic depend strongly on weather conditions and on last minute changes made to the mix formula on site, and this should be anticipated in the process of mix formulation in the laboratory. The series of European test methods EN 12274 ('Slurry surfacing – Test methods') contains a number of performance related tests, devised to optimize the formulation of slurry mixtures in the laboratory. However, there are still many questions regarding these test methods. Procedures and test conditions are not adequately described and often not representative for the conditions on site, and precision of test results is generally unknown. Therefore, the Belgian Road Research Centre (BRRC), with support of the Belgian National Bureau for Standardization (NBN), is engaged in a project involving laboratory testing and fieldwork, with the aim of improving the EN 12274 series. This has led to many recommendations for mixture and specimen preparation and the choice of test conditions in view of the expected conditions on site. As a result, precision is improved and the test results are more relevant for the performance on site, allowing for better mix formulations. The main findings of this research are presented, together with recommendations on the use of the tests in the process of mix formulation.

196

Study of interaction of asphalt emulsion with mineral aggregate surfaces by nuclear magnetic resonance

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Abstract:

There is a need to enhance the asphalt technology by enabling the production at lower temperatures, with compromising the performance as little as possible compared to the conventional approaches. Bitumen emulsion mixtures used in the cold asphalt technology offer certain advantages over hot bituminous road mixtures in terms of potential cost savings, environmental factors, energy savings and easing of logistical difficulties inherent with hot mix. During the process of mixing of bitumen emulsion with mineral aggregates processes of breaking of the emulsion occur followed by changes in physical and mechanical properties of the asphalt mixture. The purpose of this study was to explore processes occurring in bitumen emulsions – mineral aggregates and interactions near the mineral surfaces. Magnetic susceptibility gradient between solid and liquid generally results in purely NMR effects, which not related with molecular events occurring in liquid layers and in the liquid-solid interface: broadening of NMR resonance lines, accelerated NMR relaxation and NMR diffusion artefacts. One of ways to reduce the effect of the susceptibility gradient (ideally to zero) is to place a liquid between parallel flat surfaces of the studied solid support. We used mineral samples prepared as two pieces with flat polished surfaces and applied a thin layer of bitumen emulsion in-between them. Using this experimental approach we abolished artifacts related to roughness of surfaces of natural minerals, their porosity and distribution of sizes of voids intrinsic to dispersed powder used in practice. This methodology has allowed to study emulsion-aggregate surface interaction using NMR techniques. After the choice of NMR parameters, dynamic properties such as diffusion coefficients of confined bitumen emulsion and its components were measured using appropriate NMR pulse sequences.

223

New concept of durable flexible sub-base with use of deep cold recycling mixtures

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Abstract:

Nowadays, recycling of asphalt pavements is a necessity due to decreasing natural resources and implementation of the principles of sustainable development. Bituminous materials as one of the oldest construction materials are ecological due to the possibility of their total recycling. This article presents the evolution of the Polish standards for deep cold recycling technology, assesses the functional aspects of BSMs and analyses the applicability of the new technology for sub-base layer construction. The technology of deep cold recycling using cement and asphalt emulsions allows to quickly reconstruct road structure on site. The addition of cement allows to obtain increased bearing capacity of the road structure immediately after construction, but too large amount of cement causes over-stiffening and cracking of road pavement layers. The paper presents research results concerning mechanical properties of Mineral-Cement-Emulsion with various amounts of active filler and bituminous binder as well as properties of binders stabilised from experimental bitumen emulsions. The research results allow to state that the influence of bitumen emulsion content and type should be investigated on mixes containing smaller amounts of cement where the dominant role of the active filler in the MCE mix is reduced.

234

Slurry surfacing with additivated bitumen Increasing the acid index of the bitumen to improve the cohesion of the system

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Abstract:

In France like in many others countries, maintenance and preservation of the road is one of key factor for the development and the socio-economic aspect. Thus, one of the most famous technics based on emulsion technology, is the slurry surfacing, technic used and applied since decades with more than 45 million of m2 / year just in France. Ingevity, leader in chemical's additive for road construction and maintenance, has worked since more than 30 years on the development on emulsifiers and bitumen's additive (products based on vegetal's chemical from pine tree) with the aim to obtain the best solution possible. As it, during the fabrication and application of mix asphalt made with emulsion, and especially for slurry seal the key point is the cohesion of the mix. So with a direct and fast break of the emulsion and a good cohesion we obtain a good coating of the aggregates and after the application not any loss of aggregates after opening the traffic. The laboratory study is necessary to choose the good emulsifier for the jobsite (cleaning of the aggregates, temperature of application …). Also the bitumen is one of the key point. The key parameter is the acid index (in mg KOH / g, Norma NFT66-066). So in this paper, we will study the effect of an additive developed by Ingevity to increase the acid index of the bitumen and as a consequence the level of the cohesion (internal and external) of the slurry seal.

263

A field study of the mill factor contribution to bitumen emulsion particle size and distribution

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Abstract:

Asphalt emulsion dispersion is accomplished through mechanical energy and physicochemical energy. Mechanical energy (provided by the mill) divides the asphalt into fine particles and emulsion fineness increases with fractionating and dispersion capacity (mill capabilities). The mill and milling process are the primary determinants of initial particles size for a given asphalt/emulsifier system with particle size being determined by shear and time in the mill. Physicochemical energy is provided by the emulsifier to reduce the interfacial tension between the hydrocarbon phase (asphalt) and the aqueous phase (water) so as to facilitate emulsification and to create a protective film around the particles. In simple terms, sufficient mechanical energy (mill energy) must provide asphalt particles of correct size and concentration and there must be sufficient surfactant to maintain stability. The mill determines initial particle size distribution and the surfactant system determines steady state distribution. This paper presents results of plant scale studies of colloid mill tooling configuration contributions to production capacity and emulsion asphalt particles size and distribution.

349

Bitumen and emulsion properties: an innovative shared approach

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Abstract:

Some viscosity variations of the bituminous emulsions are sometimes observed in the emulsion plants, depending on the bitumen deliveries. So, this study deals with the understanding of the bitumen characteristics that may impact the viscosity variations of the emulsions. 49 samples of bitumen 160/220 were collected in different refineries for 18 months. Several physicochemical properties of the bitumens were measured as SARA content, salt content, interfacial tension… Emulsions were produced with the different bitumen samples and in order to maximize the viscosity variations, the bitumen contents in the emulsions were chosen as 69% and 71%. So, 98 emulsions were produced in the laboratory and characterized. So, in total, more than 2500 data were generated and analyzed by statistical approach. The statistical analysis of the data highlights differences of physicochemical characteristics between the bitumens depending on their resource point. No strong viscosity variations were observed on the emulsions at laboratory scale. Trends were observed between the bitumen composition and some emulsions characteristics. However, no bitumen parameter explains in itself the viscosity variations of the emulsions.

364

A new generation of semi-warm emulsion asphalt concrete : feedback and field of use

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Abstract:

Semi-warm bituminous mixes with emulsion have been developed by COLAS compagny for more than a decade. They are manufactured at a moderate temperature for maintenance of base and wearing courses. It combines the appearance and performance of hot mix with the advantages of cold mix which are flexibility and ease of use. Manufacturing processes have been developed. The mix can be obtained by a progressive and gentle warming of an asphalt mix previously manufactured in a cold mix plant. The mix can also be obtained by pre-heating only a part of the aggregates. The mixes are produced at a temperature between 70°C and 90°C. Those processes allow the use of high rates of reclaimed asphalt pavement until 100%. Reclaimed asphalt pavement is subject to a detailed identification. A softening agent may be used depending on the characteristics of the binder recovered from the RAP. The grade of bitumen used for manufacturing the emulsion is selected according to the volume of traffic and the constraints of the work to be performed. A comparison of the mechanical performances of these semi-warm mixes manufactured by different processes was carried out on samples taken directly at the coating plant. A complete characterization has been carried out. The various feedbacks made it possible to identify in a relevant way the field of use of this new generation of asphalt mix. Such mixes are economical in term of energy and non-renewable resources. It limits the emissions of volatile organic compounds and greenhouse gas emissions. It reduces consumption and saves non-renewable materials by using high rate of reclaimed asphalt pavement.

365

Enlargement of the field of use of asphalt mixes with ultra-thin emulsion asphalt concrete

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Abstract:

Bituminous mixes with emulsion in wearing course have been developed since the 1990s in France. Appropriate manufacturing processes have allowed the constitution of a wide range from very thin to thick mixes. The main area of employment is the low and medium traffic roads which represent 80% of the network in France. A complete overhaul of the French standard was published in 2016 to take into account the latest developments. Colas has developed a new concept of ultra-thin asphalt concrete with emulsion in order to widen the field of use framed by the standard. The thickness of this new generation of emulsion asphalt mix is 1.5cm. It restores the surface characteristics and impermeability of the roadway. Its particle size is 0/6mm or 0/10mm. It is manufactured using a sequential coating process that make the sand hydrophobic before final coating in a cold mix plant. This ultra-thin emulsified asphalt mix shares its field of application with surface dressing and microsurfacing. Its main advantage is the absence of stripping and the reduction of rolling noise generated at tire and road contact. This ultra-thin mix contributes to a high environmental performance thanks to a partial or total cold production, the use of emulsion and undried chippings and vegetal flux. Several projects have already been completed and are currently being monitored. This mix is layed with a conventional application workshop. It is recirculated immediately after the end of compaction. The final cohesion is reached after a curing period quite short because favored by the small thickness of the asphalt. The levels of sand patch test obtained are generally between 0.6mm and 0.9mm which guarantees a surface drainability and a suitable level of adhesion.

367

Reinforced anti-crack complex for protection of fatigued pavements: feedback from a new preservation solution

CHRISTOPHE PRIEZ

COLAS

Abstract:

In France, the budgetary limitations of contracting authorities have led to a new perspective on maintenance techniques. A new surface treatment which combines a single under layer of fiber filled surface dressing and a upper layer of microsurfacing have been developed. Adding fibers in the surface treatment, like in the microsurfacing, limits binder run off, slows the spread of cracks and enhances the performance of the complex in dense and heavy traffic. This thin layer mean that no ancillary leveling work is required. The new complex ensures waterproofing for the support, skid resistance and a homogeneous and aesthetically pleasing appearance of the treated section. Thanks to these anti-cracking, sealing and flexibility properties, this new sealing compound makes it possible to correct maintenance defects and to postpone heavy repairs. For 6 years, feedback from low to medium traffic has demonstrated the durability of this process over time. The complex helps to block the damage of a fatigued pavement. From a structural point of view, it has been noted an improvement (decrease) of the deflection of the protected pavement. The service life of highly cracked pavement is increased by several years under good service conditions. This is a major advantage for preserving road assets.

368

Consolidated state of structuring grave-emulsion

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COLAS

Abstract:

A series of investigations were carried out on structuring grave-emulsion. After 10 years of service, a consolidated state of the grave-emulsion is observed. The modulus values measured are higher than those measured after the usual lab curing protocols. This consolidated state is the ultimate state beyond which a stabilization or a drop by fatigue of the modulus can be observed depending on the structure and the traffic. It is proposed here to make an overview of our knowledge of the mechanical characteristics of the structural graves-emulsion in their consolidated state.

401

The use Anionic Bitumen Emulsions in Pavements – A state of the art review

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Abstract:

Bitumen emulsions can be either cationic with a pH of the order 2 or anionic with a pH of the order 10. The vast majority of emulsions used in the pavement construction and maintenance industry in Europe are cationic. Consequently, knowledge on their use is very limited with very little information available in the current literature. Anionic bitumen emulsions are widely used throughout North America and Africa for a range of road maintenance techniques, including pavement sealing, gravel seals, tack coating and in situ pavement recycling. The objectives of the study described in this paper were (a) to perform a literature review of the state of the art worldwide, (b) to explore the potential for the development of new emulsifiers or bitumen additives to improve the performance of anionic emulsions and (c) to explore the development of their use in Europe.

402

REVETEMENT SUPERFICIEL COMBINE (French Cape Seal)

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[1]EUROVIA, [2]EIFFAGE Infrastructures, [3]COLAS NORD EST

Abstract:

In a context of economic crisis and constrained budgets,France has been questioning maintenance techniques to optimize costs and performance.Maintaining the road heritage is a major challenge that keeps the comfort and safety qualities of the pavement for the user,facilitate economic exchanges and preserve the infrastructures from the usual climatic conditions. However,the degradation of part of the road network under the effect of traffic and weather often comes from a lack of impermeability.The technique of surface dressing is the most used surface maintenance technique,but its efficiency in terms of cost/durability ratio does not always offer the optimum sought by the customers and is sometimes badly accepted by the users because of the chip loss and its rolling noise. The technique of microsurfacing which has little defect of rejection, is also widespread.These two techniques sometimes find their limits in terms of sustainability on highly degraded or heterogeneous roads, as well as on high traffic. This is one of the reasons why “combined layers”(RSC,Revêtements Superficiels Combinés,in French)have appeared in France in different forms.Inspired from the Capeseal technique that first appeared in South Africa in the 1950s,this technique consists in carrying out a surface treatment to improve the impermeability of the roadway.It combines an opened monolayer surface dressing made from bitumen emulsion,and a microsurfacing layer, both specifically studied.This technique has the dual advantage of protecting the tired or damaged pavements at a lower cost and to give them back their service qualities, thereby extending their service life. Rapidly,the technique has been accepted all over the country as one of the most cost effective maintenance technique available. The IDRRIM organization,wrote a technical note to introduce, promote and give the best practices for the application of this technique.This article will summarize this note and illustrate the use of these “combined layers” on a few typical jobsites.