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ASPHALT PAVING TECHNOLOGY 2014

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While I have known Frank for a reasonable time this is limited to my being in the USA for only the past 20-years – hence - I would like to introduce an old friend of Frank's - Jim Moulthrop – to provide a more complete introduction and to introduce Frank Fee to the members of AAPT:

James Moulthrop Comments

Frank grew up on 36^{th} Street near the University of Pennsylvania, and graduated from LaSalle College in Philadelphia in 1967.

Frank, we have heard from several friends, began his career as an HMA plant technician and mix designer-note here the Marshall procedure-for Asphalt Technology (ATI) a Paulsboro, NJ firm. Incidentally owned by Frank's uncle Frank Devine. (Note- no collusion here!!) We are told that he was colorblind and had difficulty with electrical connections in wiring and doing titrations in soap solutions. He apparently excelled in all other areas.

Became lab manager for AC and emulsion supplier, West Bank Oil, in Paulsboro NJ, responsible for product formulation and QA and technical support-let's just call this the West Bank Oil phase.

During this time, many of Frank's exploits involved the use of polymer modified asphalt-now known in the industry as binder.

I think that is was during this time that I first met Frank- I was with Penn DOT at the time.

West Bank Oil was consumed (so to speak) by Riffe Petroleum, NJ and Frank stayed on until Riffe Petroleum was consumed by Elf Asphalt and Frank was considered the Manager of Field Engineering.

Then Elf Asphalt was consumed by Koch Materials Co. and Frank had the role as Technical Service representative. Moving on, he was then designated as the National Asphalt Technical Support representative for Koch Materials Company.

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Frank is fortunate to have a wonderful wife of 48 years Mary, two great children, and two very spoiled grandchildren,

Some things you probably know about Frank:

He is an avid skier
He is an avid hiker
He is an avid beer drinker-not too much-not too little
He is a very kind person
He is very self-contained (pleasant)-most of the time!!
He is a great breakfast cook-how do you want your bacon and eggs??
Great proponent of the Peterson Conference in Laramie

Some things you probably don't know about Frank:

Always tried to fit 10 pounds of nails in a 5 pound bag!! He would work endless hours with his only goal to accomplish everything!!

Used to drive an old Blue Mustang-we must have that in common-drove it into the ground with over 300,000 miles on it!

Is a great carpenter, has had a life time improvement project in his current house in Moylan, PA (near Media). Will they ever downsize? That remains to be seen.

Mr. President, Executive Director, AAPT Board and members, please welcome the latest Honorary Member of AAPT, my good friend, Frank Fee.

Frank Fee Remarks

I would like to thank the Association for this great honor. I feel truly humbled when I look at those who have received this in the past. These are true leaders in the field, many of whom are still contributing today. I would like to say that while I joined the association for the high level of technical activity they were involved in, I stayed with the association because of the social interaction that I enjoyed and benefit from. One of the unique aspects of AAPT is that the participants come from all aspects of the paving community, but for the one purpose of gaining knowledge of the advancement of asphalt pavements. Unlike larger focused meetings, we come together, leaving our logos behind, to freely exchange our knowledge on our specific subject.

Something that I think I'm observing is an increase in younger **active** members, who are building a network for both technical and social exchange. I know the board has put some effort into this and I applaud them for this. There are a number of changes being proposed or under discussion for the Association and it is these members that will ultimately need to define the future.

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SYMPOSIUM—PAVEMENT LAYER BONDING

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In addition to the papers listed above, the following items are also included in the CD

Recombination of Asphalt with Bio-Asphalt: Binder Formulation and Asphalt Mixes Application

Joana Peralta[a], R. Christopher Williams[a], Hugo M.R.D. Silva[b], and Ana Vera A. Machado[c]

[a]*Department of Civil, Construction and Environmental Engineering, Iowa State University, Ames, Iowa 50011-3232, USA*

[b]*C-TAC—Territory, Environment and Construction Centre, University of Minho, Campus of Azurém, 4800-058 Guimarães, Portugal*

[c]*IPC/I3N—Institute of Polymers and Composites, University of Minho, Campus of Azurém, 4800-058 Guimarães, Portugal*

ABSTRACT. *The bio-oil from fast pyrolysis is mainly produced using organic waste materials. This is a viscoelastic material, and after a heat treatment, it has a viscosity and high/intermediate thermal rheological behavior similar to many types of asphalt used in the paving industry. These two characteristics show that this material could be a good alternative to replace asphalt. In order to improve the performance of bio-oil, it was hypothesized that the addition of crumb rubber would change the rheology of the modified bio-oil, making it rheologically similar to the conventional paving asphalts. Therefore, two sources of ground rubber from used tires (GTR), from different manufacturing processes, were used to modify the bio-oil. Then, two blends were produced by adding 20% (w/w) of this bio-binder to two different asphalts, a PG58-28 and a PG64-22. The binders were aged, and then storage stability tests (separation sensibility) were performed. The rheology of the initial bio-oil, bio-binder, asphalts and resulting binder-blends were assessed by using a Dynamic Shear Rheometer (DSR), namely by performing frequency sweeps at different temperatures. The results were then used to build the master curves of the materials and to determine their high temperature continuous performance grade. Additionally, the performance related behavior of mixtures produced with this new material was also assessed in order to evaluate the advantages of its use in pavements. Therefore, two mixes were produced with the binder that showed better performance regarding thermal rheological behavior, aging susceptibility and separation tendency. These new mixes were finally studied using performance related tests that are able to estimate their future behavior in situ in different environmental and traffic conditions, in particular in regard to water susceptibility, fatigue cracking, dynamic modulus, flow number and low temperature fracture resistance. The results from this first set of experiments showed that this material can perform as well as or better than conventional asphalts over a large range of temperatures.*

KEYWORDS: *Bio-binder, bio-oil, fast-pyrolysis, rubber, asphalt-rubber, aging*

The oral presentation was made by Dr. Joana Peralta.

1.0 Introduction

Asphalt, or bitumen, is "a black sticky substance that is used for making roads" (Macmillan, 2013). Although this material is usually associated with a residue from petroleum distillation, the bio-oil from fast pyrolysis of agriculture and forestry residues can also be included in the previous definition when used as a binder in flexible pavement construction (bio-binder or bioasphalt).

The substantial increase in oil prices over the past five years was reflected in asphalt prices and also caused a reduction in its supply due to the maximization of fuel production in refineries. In fact, many refineries have installed coking facilities to further increase the production yield of transportation fuels with the consequent reduction in the supply of asphalt. This has led to (i) the production of a distillation residue that cannot be used as binder in asphalt mixtures and (ii) the substantial product development of alternative sources using biological resources such as microalgae (Chailleux et al., 2012); swine manure (Fini et al., 2012; Fini et al., 2011a; Fini et al., 2011b); cornstover (Raouf and Williams, 2010b); switchgrass (Raouf and Williams, 2010a); wood residues (Peralta et al., 2013; Peralta et al., 2012; Raouf, 2010; Raouf and Williams, 2010c; Yang et al., 2014); urban waste (Hill and Jennings, 2011); coffee and tea residues (Chaiya, 2011; Uzun et al., 2010); rapeseed and soybean (Onay and Koçkar, 2006; Şensöz and Kaynar, 2006), among others. Most of these products were developed to replace fuel as an energy source, but some of them have been used as asphalt modifiers, partial replacers or substitutes.

Recent studies suggested the use of bio-oil as an asphalt substitute to produce asphalt mixes for construction of flexible pavements. They showed that it has potential for application in asphalt as an additive, modifier or extender, especially in mixtures with polymers (Williams et al., 2009; Yang et al., 2014). In fact, the bio-oil may even replace the entire asphalt as it presents rheological properties similar to asphalt after polymer modification (Peralta et al., 2012; Raouf, 2010). However, the high melting points of most of the polymers currently used as asphalt modifiers restrict their use with bio-oil, since this last should be handled at lower temperatures. The polymer modification of bio-oil is required to improve the pavement performance over a large range of temperatures and loads. Nevertheless, some additives can be used to improve the bio-binders' characteristics, such as ground rubber from used tires (GTR). The addition of GTR to bio-oil results in a new environmentally-friendly material. The bio-binder presents good performance at low temperatures and improves the bio-oil performance at high and intermediate temperatures (Peralta et al., 2013; Peralta et al., 2012). Besides the antioxidant properties of the bio-oil (due to high lignin content), it was also found that it contains significant amounts of furfural, which is beneficial in promoting interactions between asphalt and rubber (Shatanawi et al., 2012).

The benefits of combining waste materials (such as rubber from used tires and residues from agriculture and forestry activities) with asphalt, which is ultimately the residue of crude petroleum distillation, by applying well known technologies (such as fast pyrolysis and asphalt-rubber production methods) can change the way binders for flexible pavements are envisioned. However, besides the need of a more profound knowledge of the chemistry and interaction between these different materials, it is necessary to know if this new binder can perform at least as well as conventional asphalt when applied in innovative mixtures for flexible pavements.

The first application of bio-oil in a pavement (6% asphalt replacement) occurred in 2010 in Des Moines, Iowa (ISU, 2010), and no damage can be noticed presently. Recently, a new work with 5 and 10% replacement of asphalt binder by bio-oil also showed very good performance in laboratory tests (Yang et al., 2014). Thus, it is time to move on to higher percentages of asphalt replacement by bio-oil, as this will constitute a technological upgrade with positive consequences, both economically and environmentally.

The main objective of this work is to understand the interaction behavior of asphalt with bio-oil and ground tire rubber (GTR), to effectively replace part of the petroleum asphalt by using bio-oil from the fast pyrolysis of agriculture and forestry residues and, as a consequence, to optimize the performance of asphalt mixtures with asphalt-rubber (AR).

Thus, this work aims to develop asphalt-rubber mixtures with an optimized binder using petroleum asphalt, bio-oils from fast pyrolysis of biomass, or both combined. These mixtures should have improved performance throughout the life of the pavement and the required stability during the production and construction stages. The results of this research, development and innovation work should support and promote the future use of this new product in the rehabilitation of the current roadway system, as well as in the construction of new roads and highways, in particular due to the substantial reduction in the environmental and economic costs.

In order to assess the quality of these new mixtures, their behavior must be characterized in the laboratory in order to estimate the future performance in situ. The performance tests used to characterize asphalt mixes cannot give a broad view about their performance when used individually, but when combined they can provide valuable information to preview and understand the field performance of laboratory-designed asphalt mixes. In this case, these tests are especially important because these innovative mixtures are being used for the very first time, and no previous research data can be found on the subject. The next paragraphs present the main properties related to the field performance of asphalt mixtures (including those mixtures developed in this work) and the corresponding tests used to assess those properties in the lab.

Moisture susceptibility is a problem that typically leads to the stripping of the asphalt binder from the aggregates, and this stripping makes an asphalt concrete mixture ravel and disintegrate (Brown et al., 2009). Moisture can damage hot mix asphalt (HMA) in two ways: (i) loss of bond between asphalt cement or mastic and