A Critical Review on Comparative Study on Hot Bituminous Mixes by Drum Mix and Batch Mix Plant

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Abstract: Main purpose of the asphalt plants is the production of standardized asphalt concrete rapidly in large amounts with high quality. To fulfil these purposes, two types of plants are produced and used worldwide. These are continuous (drum-mix) and batch type plants. As understood from their names, they differ from each other by their production methods. In continuous types; asphalt concrete produced continuously as the flow of aggregate. In batch types; asphalt concrete produced discontinuously, one batch at once. With technological developments, new processes and components are added to plants; however the main production processes have not changed. The main aim of this study is to evaluate the performance of asphalt plants and making comparison between a real application. To reach this aim, production steps of asphalt plants are explained and the main tasks of plants are introduced regardless of production method in the first section of this paper. In second section of this paper, the main tasks of asphalt plants are compared for continuous and batch type plants. Advantages and disadvantages of each kind of asphalt plant are introduced. The new production processes and components of each kind of asphalt plant are also investigated. Finally, the plant types compared in terms of production performance, quality of product, quality control processes, efficiency and environmental tasks. Furthermore theoretical and real production capacities, costs, production and quality losses from various problems faced during applications are discussed.

Key words: Batch Mix Plant (HMP), Drum Mix Plant (HMP).

1. INTRODUCTION

Hot mix asphalt (HMA) are used for roads and motorways pavement laying. They are producing in central or mobile asphalt mixing plants. These technological equipment are named asphalt mixing plant (HMP). They are of three types: Batch plant, Drum mix plant and Continuous mixing plants. Construction of is adopted for certain production technology of HMP. Technological process of HMP contains preparing (initial proportioning of cold aggregates, drying and heating, hot mix aggregate screening to 3 or 4 hot fractions, hot fractions, imported filler, required dust and asphalt cement proportioning by weight) and main operations (hot mixing of overall prepared materials). It is necessary to distinguish between the HMP quality and the HMP production quality. The quality of HMP production is characterised by % of its mass meeting the job mix formula or normative documentation quality (componential composition, temperature etc) requirements.

The quality of produced HMP depends as on quality of applied materials and as on manufacturing quality. High of HMP making quality can be reached by automatization of processes and computerised properly controlling them. But the main role plays operator. He must properly use possibilities supplied by modern technologies. The modernisation history and evolution of HMP constructions are investigated and presented in many works. The HMP producing technology and appropriate construction of HMP is in continuous

modernisation process. The aim of modernisation is seeking for the best HMP quality, productivity, reliability, technological universality, for less pollution of environment etc. A lot of HMP quality problems produced in AMP of different construction and automatization processes according to many aspects were analysed and investigated. The modern and using in practice methods are presented by Asphalt Institute. Sivilevičius and Vislavičius presented study of the evaluation of the random errors influence of the stochastic technological process occurring in a batch type plant on the homogeneity of the hot-mix asphalt. They presents the algorithm of prognosing mineral part composition of HMP, which takes into consideration a variation of mineral material cumulative percent passing through control sieves as well as errors of mineral material dose weight in the finite dosing.

Dosing of materials is one of the most important part of the HMP producing process. The quality of HMP making rising as systematically and random proportioning errors decreasing. The making quality rises when segregation of hot aggregate fractions is diminishing . HMP is producing by batches applying classical technology as in Lithuania as in most European countries. Quality of HMP produced by batch type HMP is assessing by applying proposed statistical methodology of control and operating .

2. LITERATURE REVIEW

The quest of perfection has lead the mankind to look continuously for the improvements in existing technology in order to make it more and more fool proof for the coming ages. For any step that is to be taken, the knowledge of path and obstacles is imperative. The review of literature in the field of research serves the same purpose. The following section aims to show the Comparative study on Hot Bituminous mixes by Drum Mix and Batch Mix Plant.

Zenonas Turskis : Multi-attribute methods in road construction can be used on the national, organization and project levels. However, most of assessment methods are seeking to find how to make the most economic construction decisions, and most of all these decisions are intended only for economic objectives. Computerised Asphalt Mixing Plants (AMP) are one of the most expensive and complicated equipment for construction of road pavements. Modern AMP is controlling by computer program, but there still are some problems. Properties of the AMP not always satisfy demands and requirements of road constructors. Quality of the asphalt hot mixtures, environmental contamination, pollution, firm economic wellbeing and possibility to satisfy demands of the hot asphalt mixture users depends on the AMP quality. This paper proposes a multi-attribute model for efficient quality assessment of the AMP. For this problem were selected 9 main quality attributes and weighted by expert ranking method. The problem is solved by applying additive assessment. The case study is presented also.

Cliff Mansfield : Batch plants range in size from a 250-lb up through 18,000-lb monsters. I've heard of a 20,000-lb behemoth but have not seen one. The plants generally are rated at one batch per minute, so a 4,000-lb plant
A batch plant's strength lies in its ability to make saleable hot mix out of almost any reasonable stockpile of specifications mid-truck if needed. Essentially, if you supply the plant with 3/4 in. and smaller aggregate you can make any mix that uses materials contained within those parameters Depending on what screens you have installed in the plant, you can make 3/8 in. and smaller mix for one truck, then switch to 3/4 in. and smaller mix for the next and still be able to blend a nice 1/2 in. and smaller mix for the third.
A batch plant utilizes numerous steps to produce hot mix. Although these steps give the plant its versatility, it is these very steps that also are its weakness to an operator who is making the same mix all day long, A batch plant spends about 30% of its time waiting on bins to weigh up, the pug to empty and similar activities. To an operator who does not have to make a lot of daily mix changes and is concerned with high production, perhaps a batch plant is not the right choice.
Drum plants are between 150 and 400 tph. The fact that a drum plant reduces the hot-mix process to its essentials is its big strength. By eliminating most of the steps taken by a batch plant to produce mix, a drum plant is able to do its job more economically. They also will operate at a higher rate of production for a given drum size because the mixing process is continuous. By the nature of their design, drum plants are limited to producing one mix design at a time. If you introduce properly gradated 1/2 in. and smaller aggregate into the unit you are going to get the same thing out of it. For a contractor who is required to supply several different mix designs in the same production run a drum plant may not be the best choice. This problem can be overcome through the use of multiple silos and a sharp operator, but multiple silos are not as practical if you must be portable.

Koenders, B.G : Within the road industry there is significant interest in asphalt technologies at ambient temperature (cold mixtures) and at intermediate temperatures (warm mixtures). They attract interest because of potential energy savings and emission reductions in the various stages of the production and the road construction process. This paper describes an innovative warm mixture process that was tested in the laboratory and evaluated in large-scale field trials (in Norway, the UK and the Netherlands) with particular reference to the production and laying of dense graded wearing courses. The key issue is to reduce the asphalt production temperatures without compromising asphalt mixture performance or quality. A balance must be found between the low viscosity of the binder which is needed to obtain good aggregate coating and good workability during mixing, laying and compaction, and an acceptable 'curing time' by having a rapid increase in mechanical strength to meet the required final asphalt properties. Studies in the laboratory and in road trials were carried out to evaluate the performance of the mixture in terms of resistance to rutting (dynamic creep), fretting and cracking (fatigue and low temperature testing). Apart from the mixture performance, studies were carried out to investigate the effect of lower temperatures on asphalt fume emissions and energy consumption. Results show the potential of this new process for obtaining energy savings and asphalt fume reductions, while at the same time maintaining mixture performance characteristics close to those of the hot mixtures.

Mansour Solaimanian, Maghsoud Tahmoressi : (University of Texas at Austin, Centre for Transportation Research), A research project was undertaken to evaluate the production and construction variability of hot-mix asphalt concrete (HMAC) containing large quantities of recycled asphalt pavement (RAP) material. Four construction projects were selected. Two of the projects used 35 percent RAP material, while the other two used 40 and 50 percent RAP, respectively. The projects differed in size with total hot-mix ranging from 12,000 to 30,000 tons. In all cases, dedicated RAP stockpiles were used. A series of tests were performed at both the hot-mix plant laboratory and the University of Texas (UT) asphalt laboratory. The tests at the plant included extraction, gradation, and asphalt content using nuclear gauge. A number of specimens were also compacted and shipped to the Texas Department of Transportation Materials and Tests Division for Hv stability testing. Asphalt recovery, penetration, and viscosity tests for both HMAC and RAP were conducted at the UT laboratory. Each day, four sublots were sampled. The results obtained from the tests were analysed. The gradation and asphalt content deviations, air voids, penetrations and viscosities, and stabilities were included in the analysis. Pay adjustment factors were determined for gradation and asphalt content deviation, as well as for air voids. In general, these high-percentage RAP projects indicated higher variability than a typical HMAC project
without RAP. The gradations of plant-produced mixtures were finer than the job mix formula target gradations, possibly because of aggregate crushing during the milling operation.

MALCOLM D. GRAHAM, WILLIAM C. BURNETT, JEROME J. THOMAS and WILLIAM H. CLARK: According to studies done in 1963-64, mixing times in asphalt plants, reduced its dry and wet mix time specification requirements by varying amounts, depending on plant size and mix type being produced. Typically, however, these times now total 10 sec dry and 35 sec wet mixing, regardless of mix type being produced. Individual plant design and condition influence time requirements for adequate distribution and asphalt coating of aggregate particles, necessitating plant-by-plant testing to qualify for new reduced times. Implications for future manufacture of mixing plants and for producer efficiency are discussed. At present, one-third of asphalt plants supplying mix for state contracts have requested and received permission to reduce mixing time, accounting for a major portion of the mix being produced.

Henrikas Sivilevičius : In most countries, the pavement of motor roads, airfields and other trafficked areas is made of hot-mix asphalt (HMA) mixture prepared by asphalt mixing plants (AMP) of various designs. The total output of HMA mixtures shows the dynamics of national road transport infrastructure's development, corresponding to the increasing number of vehicles, traffic intensity and axle loading. HMA mixtures are made by using various technologies, which have some advantages and disadvantages. The paper presents technological schemes of making HMA mixtures used in Lithuania and other countries. The development of AMP and technical and technological characteristics of new computer-aided AMP models used at various asphalt production companies (APC) were analysed. Based on the data provided by the European Asphalt Pavement Association (EAPA), the correlational-regression relation between the country's area and the amount of the produced HMA mixtures was established. The data on the total output of HMA mixtures in Lithuania cannot be found in the information provided by EAPA. For the first time, the dynamics of the production of HMA mixtures by particular APC in Lithuania over the last 10 years (1998–2007) has been determined based on the data directly obtained from their manufacturers. The data were analysed and compared to the output of HMA mixtures in other countries and the dynamics of the development of AMP models used in Lithuania and changes in their numbers were determined

Petkevičius, Kazys : It was determined that poor quality of asphalt concrete is the main cause (65 %) of early fatigue cracking of asphalt concrete pavement of roads in Lithuania and neighbouring countries with similar climatic conditions. The poor quality of asphalt concrete is mainly predetermined by **production errors of hot mix Plant (HMP)** and designed suboptimal mass ratio of constituents. The development of theoretical principles for producing the best componential composition of asphalt concrete is highlighted. Optimal values of the portions of coarse aggregate, fine aggregate, filler and bitumen recommended by different authors are given. The main causes of deviations from the optimal composition of HMA produced by asphalt mix plants of different generations are systematised. The dynamics of rapid cracking of asphalt concrete paving of Lithuanian roads is shown emphasising the inadequacy of HMA structure and properties to increased traffic intensity and axial workloads. The permissible values of asphalt concrete components, optimal under the actual climate and traffic conditions, ensuring highest asphalt concrete resistance to fatigue and rational (8-9 years) service life, during which the cracked pavement area does not exceed 8 %, are proposed. A quality assurance method has been developed based on mathematical statistical methods. It helps avoid deviations of component proportions, occurring in the process of production, from the project proportion and to increase the homogeneity of the product.

Lutes, C., R. Thomas, AND R. Burnette : The report provides data from pilot-scale measurements of the emissions of specific air pollutants from paving asphalt both with and without recycled crumb rubber additives. The methods used in this work measured emissions from a static layer of asphalt maintained for several hours near the highest temperature likely to be encountered in a "real" paving operation (176 C). Although concentration levels observed for most species were in most cases near the detection limits of the analytical methods applied, statistically significant emissions of a variety of pollutant species were observed. Volatile organic compound analyses showed significant amounts of benzene emitted from both types of asphalt studied. An analysis targeting 16 polycyclic aromatic hydrocarbon (PAH) species of primary interest revealed significant emissions of 7 of the 16 species when the AC10 asphalt without rubber tests were compared to the facility blank tests. The emissions of 5 of 16 PAH species were significantly higher in the AC10 thin layer with rubber tests than in the facility blank tests. The concentrations observed, though significant, were close to the limit of detection. Statistically significant emissions of both total particulates and PM10 were found from both types of asphalt hot-mix material tested.

Freddy L. Roberts : Asphalt has been used as a construction material from the earliest days of civilization, but though it has long been used as a waterproofing material in shipbuilding and hydraulics, its use in roadway construction is much more recent. A recent survey revealed a total of over 2.3 million miles of hard-surfaced (asphalt or concrete) roads in the United States, of which approximately 96% have asphalt surfaces. Asphalt mixture consists of asphalt, coarse and fine aggregate, and a number of additives occasionally used to improve its engineering properties. The purpose of mixture design is to select an optimum asphalt content for a desired aggregate structure to meet prescribed criteria. The demands and reliance upon America's roadways for mobility and commerce have increased substantially over the past three decades. The highway network is not only the economic backbone of the country, but it also provides the only transportation access to a growing number of communities. This paper presents a review of the past, present, and future trends in asphalt mixture design as the methods have evolved in an attempt to meet the ever-increasing demands of traffic.

H. E. Friedrich : Hot-mix asphalt paving plant operations and the associated air pollution control problems are presented. Field observations and test data are included for full scale installations. Comparisons are made for various types of control equipment and their effectiveness. The dry cyclonic units offer the least cost expenditures, lowest space requirements, and can collect the fines in a usable condition. Wear can often be a problem, and their efficiency capabilities limit their use as total collection devices. They no longer are suitable as total collection units in many localities. Their role is being relegated to that of primary and secondary collectors. Wet collectors of several types, particularly the more sophisticated and high energy units, are capable of satisfying higher efficiency requirements. They offer space advantages and are in the medium cost range. Wear is generally no problem, however, corrosion can be a problem depending on the amount of sulphur in the rotary dryer burner fuel. Settling tanks, ponds, or pits are necessary for settling of the collected dust. The dust, as collected, is not readily reusable as mineral filler in the mix. Fabric collectors are capable of satisfying the most stringent codes. They offer the greatest cost advantage for material recovery to be used as mineral filler. First cost and space requirements of fabric filters are highest of the three classes of equipment discussed.

CONCLUSION

Type of Mixes produces by both HMP (Hot Mix Plant) which is Drum mix and Batch mix plant have different properties, Hot Bituminous mix produce by Batch type have more Stability than Drum type bituminous mix for same type of mix (i.e. Bituminous concrete), Mixing time of Batch type is less than Drum type which conclude productivity of Batch type is much better than Drum type. Burning fuel consumption is more in drum mix plant Whereas in case of wastage 2 to 3 % of raw material is wasted by Batch type where Drum mix plant have less wastage, setup and installation of batch mix plant is difficult as compare to drum mix and also needs more area for installation. Use of HMP varies according to the type of project and location, in hilly terrain drum mix plants are more suitable than batch type in plain terrain Batch type mostly in use.

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