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A Review of Recycled Asphalt In Rigid Pavement

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Abstract: Recycled Asphalt Pavement (RAP) is designed as another of the construction wastes produced by the infrastructure and reconstruction sector. RAP is a product of current surface removal where the reconstruction takes place. The evolution of road construction in Malaysia has increased the waste of asphalt aggregate but the uses of recycled asphalt bitumen as one of the materials in road construction in Malaysia was said to be very effective. The uses of recycled asphalt pavement (RAP) in road work lead to various quality of asphalt and able to support high loading if applicable proportion with a maximum percentage in the design mixture. In create a new construction and insulation material, the modification is needed in concrete mixture with added such as an anionic bitumen emulsion. RAP was mixed in a rigid pavement mixture to replace aggregate. By using recycled bituminous in rigid pavement as road construction, this new mixture can be absorbed more vibration from vehicles on the road as rigid pavement. It can be extended work in the future with a variation of percentage of the mixture to produce maximum strength.

Keywords: Reclaimed Asphalt Pavement, Rigid Pavement, Road Construction, Aggregate.

1. Introduction

The waste production from maintenance road, asphalt production and reconstruction has increased highly over past the years. These construction waste materials that will cause the landfill area to be full and compact and need proper waste disposal methods. The best way to reduce waste disposal of road construction with recycling or reuse. Recycle for these construction materials needs a suitable sector, so that their use can be truly utilized. Recycled Asphalt Pavement (RAP) is designed as another of the construction wastes produced by the infrastructure and reconstruction sector. RAP is the process of removing existing pavement on which the surface is rebuilt. According to the statistics published about road sector by ASEAN, Japan Transport Partnership, the ratio of pavement road to total length road are reached about 80.9%. As a financial article by the Department of Statistics Malaysia, the total expenditure incurred for road maintenance program has been increased to RM3:43 billion in 2013.

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materials and an important factor to be considered to maintain the road system that is efficient, safe and economical have caused a huge increase in demand for restoring the existing road pavement [1]. The use of such additives is not required in this scope of testing due to low percentage of RAP.

2. Materials and Methods

The Methodology for this project will be chosen based on the best method that we have studied from previous project. **Figure 1** shows the procedure in methodology using in this study. We will be reading and analyzing about 30 journals or articles and projects to come out with the best methodology to be used in our upcoming project. To get this review paper done, we had used Scopus, Google Scholar and ProQuest to search for articles and previous studies about this case. These sites are very useful along the way for us to get this review paper done. There are thousands article that can be used in studying for our case study. Those sites are useful for having a lot of information and update our knowledge about recycled asphalt in rigid pavement.

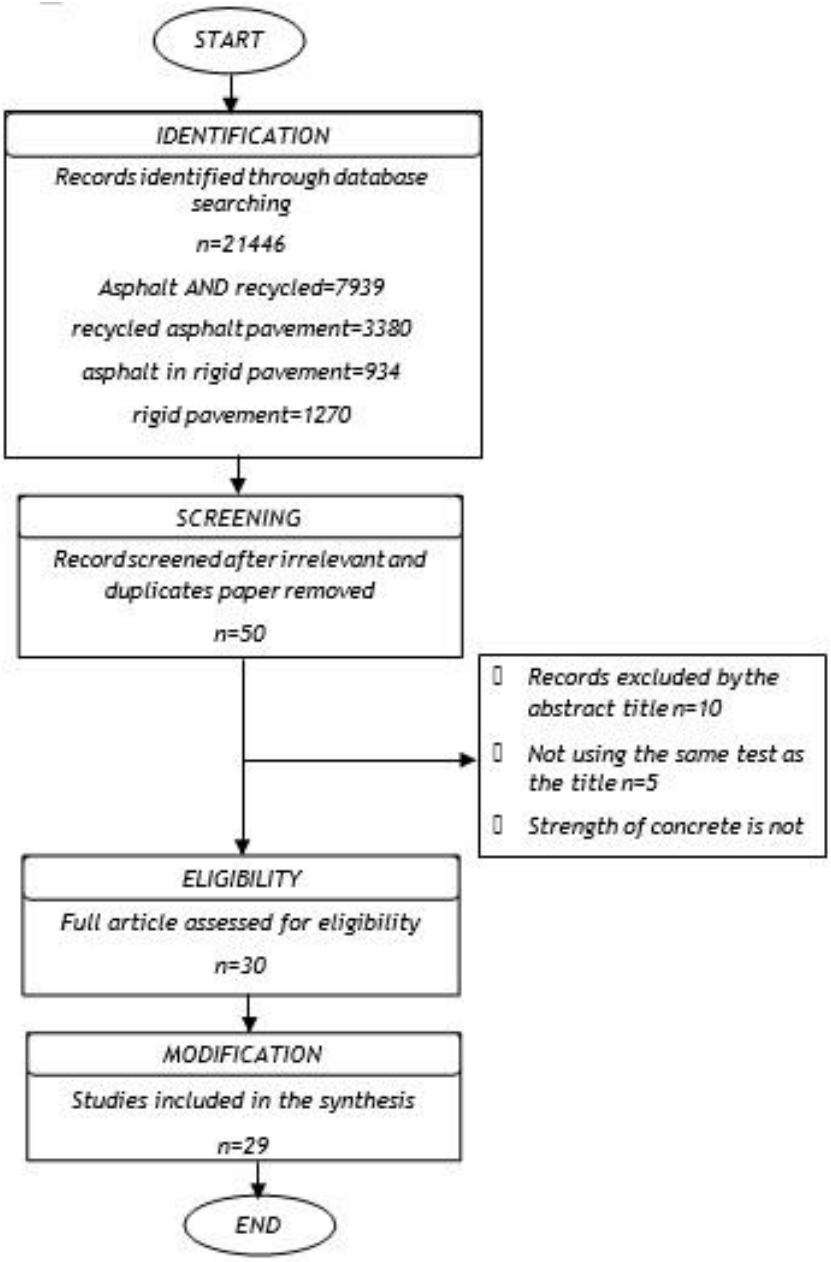

Figure 1: Procedure of work in this study

Science Direct has been used to search about the recycled asphalt in rigid pavement which is related with using some keywords. The keywords used for searching are “Asphalt AND Recycled”, “Pavement Strength”, “RAP Pavement”. While using Scopus, the keywords that have been used are “Asphalt AND Pavement”, “Rigid Pavement”, “RAP Pavement”. There is a lot of results that were identified from the google search engine.

Next, the results from the first step were selected and analyzed either it is suitable for this project or not. The results of the journal and articles obtained will be checked or ascertained to ensure the journal or article are follow the criteria that have been set. The things that must be ensured are the timeline of article such as not too long with the current year, the languages used and the literature type like journal and thesis only. In the next section are the materials and methods section, or known as the methodology part were describes all the steps, procedures and information needed to follow to find the data and results of the current study.

3. Results and Discussions

The results and discussions were highlighted in this subsection.

3.1 Results

Recycled bitumen pavement has higher resistance to shear and curve if it is mixed in rigid pavement and is able to withstand higher vibration forces [2]. Based on test material of RAP that shows in **Figure 2**, there is little variation in mixed design and it can be assumed that any in consistence during testing is caused by these differences. The higher temperature (20’c), Multigred (MG)-15% has a greater resistivity to fatigue than MG-15% (10’c). It has been reported that the performances of new asphalt pavement would be as equally acceptable intermediate rate of 25% RAP. The use of RAP in Ultra High Performance Fibre Reinforced Concretes (UHPFRC) modified design mix term of mechanical strength. **Figure 3** has shown that the effect of 15% of the RAP in the mixture has reduced the compressive strength, while if more than 15% of the RAP, the UHPFRC is unable to withstand higher loads and does not achieve the mean strength to be achieved. The results of the study can conclude that the compressive strength is reduced for higher RAP content mixtures and does not exceed 20% for mixed materials. Indirectly, it shows that RAP is able to withstand higher loads if it fits within the maximum percentage for the design mixture.

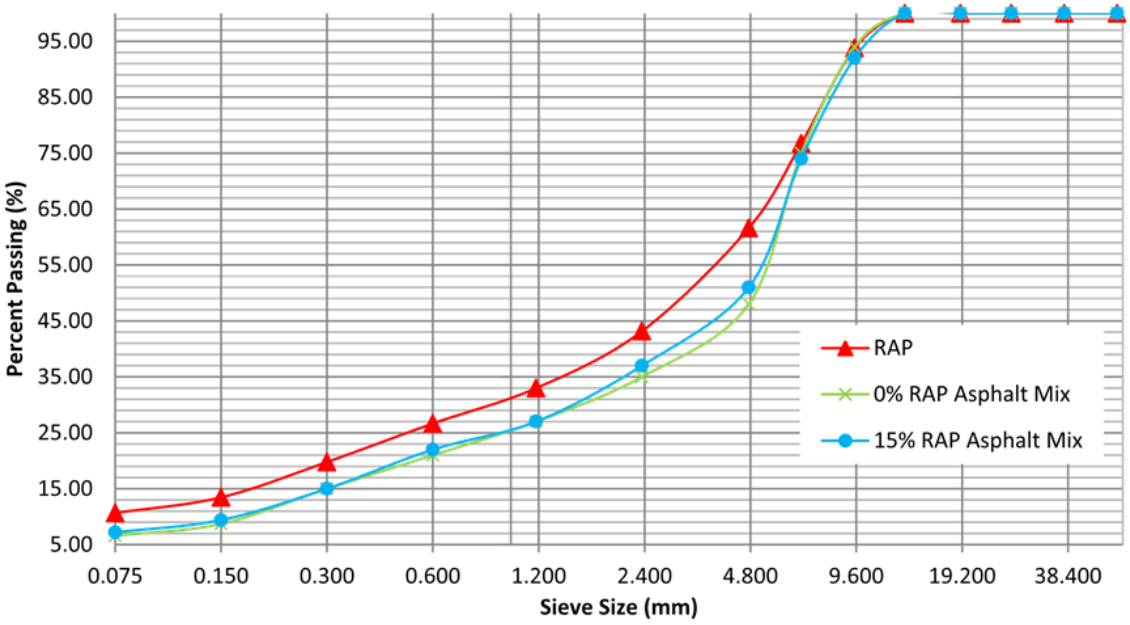

Figure 2: Aggregate grading chart

Using recycled bitumen pavement can result in the preservation of original geometric parts and reduce conflicts in construction waste disposal. Recycled mixtures with emulsions have low modulus of stiffness, as well as making relatively low resistance to traffic loads or water reactions. RAP heating will increase the workability of the mixture which can be easy to operate, but can reduce the shear force pressure of a structure [3]. The hot recycling mixture can reach the maximum load borne at a temperature of around 20ºC. A hot recycling mixture with a ratio of 70/100 bitumen has a higher maximum load than a hot recycling mixture with 160/220 bitumen. All three cases produced the same stiffness at 5°C. Hot and semi-hot recycling mixtures produce almost identical results, while cold recycling mixtures at -5°C have different reactions resulting in maximum load and lower stiffness. recycled asphalt pavement has been used on rigid pavement type roads to replace part of the aggregate. This recycled asphalt is used to enable the solid pavement to be able to absorb vibration from past vehicles which can increase the lifespan of the pavement. if the rigid pavement has a higher vibration absorption element, it brings more comfort on the drive as well as reduces accidents as it reduces the risk on slippery surfaces during rain [4].

The higher temperature for all ratio mixture before its failure is below than 64 °C for the binder on the 15% of RAP mixture used. However, the higher temperature for all mixture ratios of RAP is below than 70 °C. A modified asphalt mixtures of 15% of RAP have a lower rigidity value than an asphalt mixtures of 30% of RAP during the operating process [4]. The Compressive strength of concrete aggregate mix decreases incorporating recycled concrete aggregate due to weak adhesive aggregates around recycled aggregate particles that disrupt the aggregate bond due to the presence of small amounts of tar bitumen [5]. The Addition of RAP has reduced the compressive strength of Alkali-activated RAP Concrete Paver Blocks (AARCPB). This is because there is the presence of bitumen that has been disturbed in its original molecular form when the asphalt recycling process in RAP aggregates. The reduction of the concrete compressive strength of cement due to RAP of inclusive transition zone interface (ITZ) were decreased, but increasing the porosity in the ITZ, and reduction of bulk modulus. The presence of asphalt around the aggregate in the concrete mix causes the formation of poor bonding between the aggregate surface and the cement matrix caused by the relatively oily asphalt surface [6].

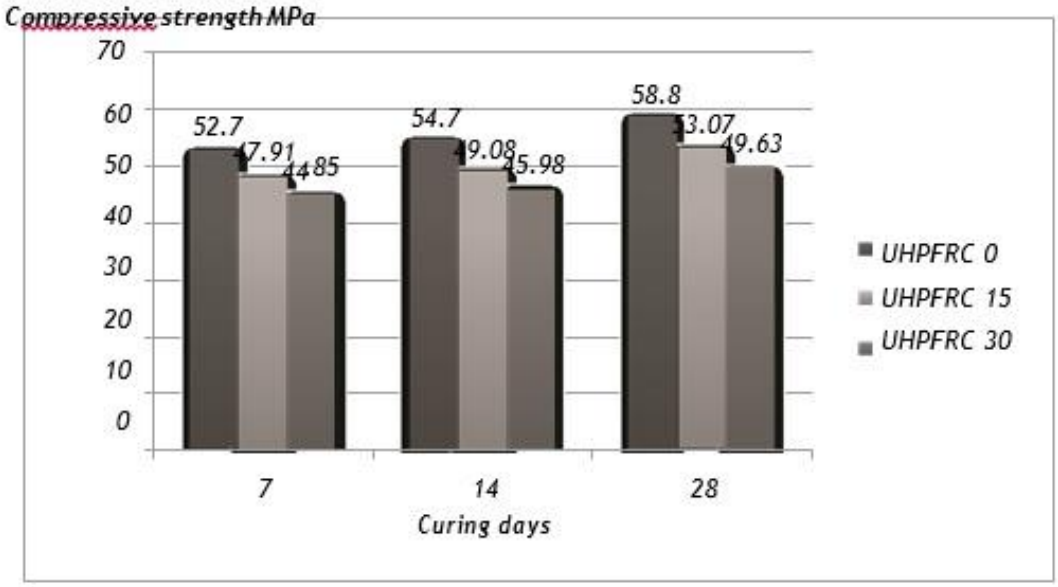

Figure 3: Compressive strength of various UHPFRC design mix with RAP

3.2 Discussions

The results of the research obtained show that the modification in the variation of concrete mix with anionic bitumen emulsion has the potential to produce new construction materials as well as insulation with increasing resistance of a material. Due to the presence of hydrophobic properties, bitumen emulsion enhances bonding in concrete. In contrast to ventilation mixtures, it does not significantly reduce the compressive strength of concrete, as it does not cause air pores on the concrete. As a result of the hydrophobic effect, bitumen emulsions reduce the penetration of water and other liquids into the resulting concrete structure. By using this emulsion in combination with concrete mix is to produce concrete with compressive strength up to 60 MPa and very low liquid absorption ability of less than 2%. Modified bitumen concrete has very high resistance properties to adverse effects on the environment, especially for the freezing and thawing of various materials [7].

Bitumen emulsion can increase the waterproofing capacity of concrete through its hydrophobic properties and this can have a good effect on the durability of its structure. Apart from the concrete mix, the rigid pavement can also be mixed with a bitumen-bound asphalt layer. But the incorporation of existing pavements may be needed at an early stage to eliminate reflective cracks and improve the quality of surfaces and structures. Therefore, recycled asphalt is a sustainable and good strategy to restore existing pavement or improve on solid pavement for a desired role. Cold In-place Recycling (CIR) procedure can increase the strength for recycled materials sufficiently, allowing for a longer pavement life and less need for maintenance of pavement structures [8].

Recycling in a Cold Place (CIR) consists of the process of building an existing pavement and reusing crushed material directly to reuse the recycled layer without heating the surface of the coating. stabilizing or rejuvenating materials are used to improve the mechanical properties of the mixture to be used. Based on the hardware and equipment available, the CIR process can reach 100mm to 150 mm for depth. it may be more than 300 mm deep in combination with stabilizing agents, such as foam or acrylic asphalt and cement. Although the Full-depth Reclamation (FDR) method can restore the quality and stability of the pavement structure already in use, increase the structural capacity and shelf life of the structure itself as well as improve the mechanical properties of the recycled coating by using additives such as stabilizing agents [8].

More broadly, full-depth reclamation with foamed asphalt (FDR-FA) or referred to as cold in-place recycling with foamed bitumen (CIR-FB), alters the pressure-bearing layer to produce suitable new material from road construction waste for stabilization base / sub-base layer, using up to 100% recycled material. The foam asphalt stabilization process produces a relatively strong and durable pavement for its longevity. In addition, cost and time can be saved as well as able to eliminate structural defects and failures caused by wear and tear from use. Some past researchers have found that guidelines for setting higher strength requirements (stability) encourage the use of high cement content and the addition of large amounts of new aggregates with good parameters. Emulsions are usually added only to allow the new product to be a mixture of mineral-cement-emulsion and able to produce materials with high rigidity [9].

Mineral-cement-emulsion (MCE) mixtures can be broken down into two types. Among its types are mixtures with a dominant bitumen binder (flexible layer) and a mixture with a dominant hydraulic binder (rigid layer). Based on the types available, to maximize the use of materials captured or reused from old pavement, MCE is the best choice. Replacement of granite with RCA used for this research to improve the stability of asphalt mixtures. This is in line with the findings of Kareem work [10] who found that stability had increased from 17600 N for granite mixtures to 18600 N for the participation of 60% Recycled Concrete Aggregates (RCA). Besides, a number of other researchers have found that the use of crushed cement and dust as fillers in asphalt mixtures can improve the stability and performance of RCA [11, 12]. The small contribution of cement into the matrix from the attached aggregate can make the key factor of increased stability [13].

4. Conclusion

The present study aims to understand the reclaimed asphalt pavement (RAP) which is considered as one of the material that used for road construction. The RAP is used to minimize the cost of raw material for road construction and to prevent environmental pollution. The process of producing aggregates materials can disrupt to the environment and economy due to the severe lack of natural resources. The results show that recycled bituminous pavement have the higher of resistance to shearing and less reflective cracking for road construction. It also can improve the quality of pavement if the reclaimed asphalt mixture are been applied for road. The optimum percentage of the design mix can affect the compressive strength of road either it can resist the higher loads or not.

The Workability of RAP mixture can be obtained by heating the reclaimed asphalt and also can decrease the shear stress. the emulsion in combination with plasticizer, the pavement can obtain up to 60 MPa of compressive strength. RAP are usually can be milled from the asphalt pavements either it is about to destruct or fix. The performance of the RAP mixtures are mainly depending on the amount of RAP percentage that use in mixture or the method for constructing road or pavement. RAP can save the new asphalt binders and aggregate. Cold recycling (CR) can be divided into three types which are the cold-in place recycling technology (CIR), cold central-plant recycling technology and full-depth reclamation process (FDR) [14].

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