



A Review of Innovations and Challenges in the Use of Asbuton for Road Infrastructure

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Abstract: This article reviews the latest technological innovations in the use of Asbuton, natural asphalt originating from Buton Island, for road rehabilitation. Asbuton is known to have a number of advantages, such as its high bitumen content, resistance to extreme temperatures, and the potential to provide economic benefits to local communities. Various treatment methods, including conventional methods, Hot Water Process, and Cold Paving Hot Mix Asbuton (CPHMA), have been studied to improve the quality and efficiency of their use. In addition, innovations such as polymer modifications, cold recycling techniques, and the implementation of modern quality control systems are also discussed as factors that can improve Asbuton's performance and sustainability. Despite having significant potential, challenges in terms of production facilities, standardization, skilled human resource development, and regulations still need to be considered. The recommendations proposed in this review include accelerating the standardization process, training for the workforce, investment in infrastructure, and collaboration with research institutions to support the optimal and sustainable use of Asbuton in road infrastructure development.

Keywords: Asbuton, road rehabilitation, technological innovation, challenges, infrastructure.

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Introduction

Road rehabilitation is an important aspect in the development of transportation infrastructure in Indonesia. Geographical challenges and diverse distribution of resources demand innovation in the use of construction materials. In line with that, the government also encourages the use of local materials as an effort to substitute imported materials, especially in the construction of road infrastructure. One of the Indonesia's great potentials is Buton Asphalt, or better known as Asbuton, which is an indigenous natural resource in Indonesia that contains natural asphalt in rocks. With abundant reserves on Buton Island, Southeast Sulawesi, Asbuton is a promising alternative to reduce dependence on imported oil asphalt. In recent years, innovations in Asbuton utilization technology have been developing, especially in the field of road rehabilitation. This innovation aims to increase the efficiency and effectiveness of road infrastructure work while supporting environmental sustainability. Asbuton can be classified into several types based on its physical form and processing process, such as pure asbuton, modified asbuton, granular asbuton, and powdered asbuton. Buton asphalt minerals are generally composed of limestone, with a fairly good level of homogeneity of

bitumen content [1]. Research shows that the use of asbuton can improve the performance of asphalt mixtures, especially in heavy traffic conditions [2][3]. On the other hand, the increasing need for economical and sustainable road pavement materials encourages the use of local resources. The government has also begun to encourage the substitution of oil asphalt with local materials such as Asbuton as a form of national independence in the road construction sector. Research and development continues to be carried out to ensure that the use of Asbuton meets technical standards and road safety, while providing added value to producing areas.

Literature Review

Buton asphalt (Asbuton) is a type of natural asphalt found in rock formations on Buton Island and the surrounding area in Southeast Sulawesi, Indonesia. The geological process that produces Asbuton involves the migration of petroleum to the surface, which then permeates into porous rocks, oxidizes, and hardens, thus forming bitumen-containing rocks [4]. According to Mardiansah et al. (2018), the bitumen content in Asbuton varies between 10–40%, which is quite high compared to natural asphalt from other countries, such as the United States (12–15%) and



France (6–10%) [5]. With Asbuton reserves estimated at 650 million tons, Indonesia is the largest producer of natural asphalt in the world [6]. Research by Employee et al. (2021) shows that the characteristics of asphalt mixed with Asbuton based on Marshall properties show good performance at hot and cold temperatures [1]. In fatigue testing, the use of granular Buton asphalt was proven to extend the service life of paved mixtures when compared to unmodified paved mixtures [7]. In addition, other studies have also explained that the addition of granular Buton asphalt to the asphalted mixture can reduce the total permanent strain, thereby increasing the resistance of the mixture to permanent deformation [8]. The adaptation of the use of Asbuton has also begun to be directed to various types of pavement mixtures, such as hot asphalt mixtures (*Hot Mix Asphalt*), semi-hot mixtures (*Warm Mix Asphalt*), to cold mixtures (*Cold Mix Asphalt*), each of which is adjusted to traffic conditions and climate in the field. In addition to improving mechanical performance, the use of Asbuton is considered to provide benefits in terms of environmental sustainability because it utilizes local resources and can reduce the carbon footprint produced from the production and distribution process of oil asphalt. With its wide application potential, Asbuton is an important focus in the latest research in the field of road pavement technology.

Results and Discussion

1. Potential and Advantages of Asbuton

Asbuton, as a type of natural asphalt originating from Buton Island, has enormous potential to be used in road infrastructure in Indonesia. With a bitumen content that varies between 10–40%, Asbuton shows higher levels compared to natural asphalt from other countries, such as the United States (12–15%) and France (6–10%) [5]. This makes Indonesia the largest producer of natural asphalt in the world with reserves of 650 million tons [6]. Asbuton's technical advantages, such as heat resistance and stability in extreme conditions, make it an attractive choice for road pavements [9]. Research has also shown that the use of asbuton can improve the performance of asphalt mixtures, especially in heavy traffic conditions [2][3]. Another advantage of Asbuton is its flexibility in various construction methods, such as hotmix, coldmix, and cold paving hot mix Asbuton (CPHMA) methods, which support project implementation in various geographical conditions. This adaptability is an added value in expanding its application to national projects and remote areas. In addition, the use of Asbuton as a local material also provides strategic advantages in the context of the national economy, because it is able to reduce dependence on imported asphalt oil which fluctuates in price. The existence of Asbuton also encourages the growth of local industries, creates new jobs in the mining and processing sectors, and supports the equitable distribution of infrastructure development between regions. With the synergy between resource availability, technical excellence, and economic benefits, Asbuton has the potential to become a major pillar in sustainable road development in Indonesia.

2. Classification and Methods

The utilization of Asbuton can be classified into several types, including pure, modified, granular, and powdered Asbuton. Each type has different characteristics and applications, which allows flexibility in its use. Asbuton can be classified into several types based on its physical form and processing process, namely

pure asbuton, modified asbuton, granular asbuton, and powdered asbuton. Pure asbuton is natural asphalt in the form of rock that contains natural bitumen and has not undergone a modification process. Meanwhile, modified asbuton is asbuton processed to improve the quality and consistency of bitumen, including the addition of additives. Granular Asbuton is asbuton that is crushed into granules of a certain size, while powdered Asbuton is processed into a fine powder form to be used as a filler in asphalt mixtures. Utilization methods such as Hot Water Process (HWP), conventional methods, and Cold Paving Hot Mix Asbuton (CPHMA) show innovations in Asbuton extraction and application. HWP, for example, improves the efficiency of bitumen extraction. This opens up opportunities for the application of HWP in remote areas, especially when combined with semi-portable processing systems. While the CPHMA method of Cold Paving Hot Mix Asbuton (CPHMA) is a hot mixing technology that uses modified asbuton, but the installation is carried out at ambient temperature so as to reduce energy consumption and exhaust gas emissions because the manufacture of the asphalt mixture uses a lower temperature than the conventional method [10]. Research has also shown that the use of Asbuton in asphalt mixtures can increase resistance to moisture damage [11][12]. The use of different types of Asbuton also allows the application of technology tailored to the needs of the project in the field. For example, powdered Asbuton is more suitably used as a filler in asphalt mixtures to improve structural stability and fill inter-aggregate cavities [19]. Meanwhile, granular asbuton type B 5/20 or B 5/25 has been proven to be efficient in the implementation of pavement projects in areas with limited AMP access, as it can be mixed directly without the need for additional modification processes [13]. With flexibility in the type of material and application method, Asbuton provides a variety of technical options according to field conditions and facility availability. This makes Asbuton one of the adaptive materials in supporting efficient and sustainable road construction.

3. Innovation and New Products

Recent innovations in Asbuton utilization technology, such as Granular Ready-to-Use Asbuton (BGA), Asbuton PG70, Semarbut Asphalt Type I and II, and PMBA show progress in the development of products that can compete with asphalt oil [13]. For example, the use of Semarbut Asphalt Type I and II, which is the result of a modification of 60/70 penetration asphalt with emulsified Asbuton extraction, has also shown an improvement in the characteristics of asphalt mixtures. Studies show that Semarbut Asphalt Type III, which uses waste oil, can improve the performance of hot asphalt mixtures (AC-WC) in terms of stability and resistance to deformation [20]. Asbuton PG70 which is the result of Buton asphalt modification which is improved in quality to withstand heavy traffic loads and high temperatures. Based on research, it is shown that Asbuton PG70 has a better stability value than conventional oil asphalt, thereby increasing the durability of road pavement and reducing the need for routine maintenance [21]. One of the other important innovations is the development of Polymer Modified Buton Asphalt (PMBA) which improves elasticity and resistance to plastic deformation. This technology makes road pavements more resistant to heavy traffic loads and extreme temperature changes, while extending the life of the road by up to 30% compared to ordinary Buton asphalt [22]. In addition, another innovation is the recycling method such as the use of used oil as a preservative material in the Asbuton mixture, so that it has

several advantages such as being able to restore the strength of the pavement and maintain the geometry of the road as well as overcoming dependence on new materials [23]. The quality control and blending systems in the Asphalt Mixing Plant (AMP) also contribute to the consistency of bitumen distribution in the mixture, which is important for the quality of road pavement [14]. In addition, studies show that modification of Asbuton with additives, such as polyethylene, can improve the mechanical performance of asphalt mixtures including increased Marshall stability and resistance to permanent deformation. [15]. Analysis of the effects of Asbuton on porous asphalt mixtures for heavy traffic also showed positive results [16]. Overall, technological innovations in the use of Asbuton show great potential in supporting more efficient, economical, and sustainable road rehabilitation. The development and application of this technology in the future is expected to provide solutions to Indonesia's infrastructure needs.

4. Challenges in Implementation

Although Asbuton has many advantages, its implementation in the field still faces various challenges. Technical, logistical, and market acceptance aspects are the main obstacles. Despite instructions from the government to reduce asphalt imports and utilize Asbuton, implementation in the field is still minimal. The utilization rate of the Asbuton processing industry is less than 5%, indicating the need for more assertive policies and real support from the government to encourage the widespread use of Asbuton [24]. In addition, the lack of understanding and skills of human resources in processing and applying Asbuton technology is a significant obstacle. Adequate education and training are needed to improve the competence of industry players in using Asbuton effectively. The use of Asbuton requires modifications to existing Asphalt Mixing Plants (AMP), as well as additional technologies for processing and mixing. In addition, supporting infrastructure such as ports on Buton Island is still inadequate, hampering the distribution and logistics of Asbuton to various regions [25]. Some types of Asbuton require special heating or mixing with additional ingredients, which can increase the cost and processing time [9]. In addition, the lack of support from comprehensive national standards (SNIs) for all types and their applications complicates the procurement and quality inspection process in road projects [5]. More research is needed to address these challenges and increase market acceptance of Asbuton as an asphalt alternative [17][18]. The government has also issued a strategic policy that supports the use of Asbuton in the construction and rehabilitation of road infrastructure in the decree of the Minister of PUPR No. 18 of 2018 concerning the Use of Asphalt Products in the State, which states that road construction projects financed by the State Budget/Regional Budget must prioritize the use of asphalt products in the country, including Asbuton. The use of Buton asphalt additives has also shown a positive effect on resistance to moisture damage [1] and can improve grip [2]. In addition, research on the influence of limestone and buton granular asphalt (BGA) on density also provides new insights into the development of asphalt mixtures [19]. These findings show that the development of mixing technology and the selection of appropriate additives can be key in optimizing Asbuton performance in the field. In addition, it is also important to encourage collaboration between governments, academics, and industry in creating an ecosystem that supports innovation and efficiency in the use of Asbuton. The development of adaptive regulations, incentives for investment in mixing

technology, and sustainable socialization programs can be strategic steps to accelerate the adoption of Asbuton nationally. Increased access to technical data and best practices from pilot projects is also needed so that stakeholders have a clear reference in designing and implementing projects involving Asbuton.

Conclusion

Buton asphalt (Asbuton) has great potential as an alternative material for road infrastructure in Indonesia. With a bitumen content of 10-40%, Asbuton offers higher quality than natural asphalt from other countries and has abundant reserves. Research shows that its use can improve the performance of asphalt mixtures, extend service life, and reduce permanent deformation, providing significant advantages in sustainability and cost efficiency.

Although Asbuton has technical advantages and broad application potential, its implementation still faces challenges, such as low utilization rates, lack of understanding and skills in processing, and inadequate infrastructure. Strict policies are needed from the government to encourage the use of Asbuton, including education, training for industry players, and the development of supporting infrastructure.

Innovations in the utilization of Asbuton, including the development of new products and efficient application methods, can support more economical and sustainable road rehabilitation. Collaboration between government, academia, and industry is essential to creating an innovation ecosystem. With this strategic step, Asbuton has the potential to become a major pillar in the development of sustainable road infrastructure in Indonesia, reducing dependence on imported asphalt oil, and supporting local economic growth.

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