CHAPTER III

THEORITICAL BASIS

3.1. About Polyethylene

According to Agboola et al. (2017), Polyethylene (PE) is a member of the important family of polyolefin resin, and the most widely used plastic in the world. They are prepared by the catalytic polymerization of ethylene. It is a thermoplastic polymer consisting of long chains, produced by combination of the monomer molecules, i.e., ethylene. The higher the molecular weight of polyethylene, the more resistant it is to stress cracking or the higher the impact resistance. Therefore, based on Leksono (2013), Polyethylene is divided into 4:

3.1.1 LDPE (Low Density Polyethylene)

Low-density polyethylene is a thermoplastic made from the monomer ethylene. It was the first grade of polyethylene. Usually supplied in the form of thin sheets or already in the form of plastic parts through the LDPE bottle injection molding process.

3.1.2 HDPE (High Density Polyethylene)

Slightly Stiffer than LDPE. It offers fairly good chemical resistance but is difficult enough to process into component parts. Usually used as plastic bottle or liner for chemical tanks.

3.1.3 HMWPE (High Molecular Weight Polyethylene)

Widely used as anti-friction parts and abrasion-resistant plastic components as conveyors or material handling. HMWPE is also the best choice for food chopping boards.

3.1.4 UHMWPE (Ultra-High Molecular Weight Polyethylene)

Ultra-High Molecular Weight Polyethylene has extremely long chains, with a molecular mass usually between 3.5 and 7.5 million Dalton. The longer chain, serves to transfer load more effectively to the polymer backbone by strengthening intermolecular interactions. This results in a very tough material, with the highest impact strength. It is the most ductile and tough because of the smallest coefficient of friction, excellent resistance to wear / abrasion (lowest wear rate) and excellent impact resistance (no break).

Because its capabilities, Thermoplasticsblog (2016) published that UHMWPE can be used for super strong fibers. The fibers are cut-resistant gloves, bow strings, climbing equipment, automotive winching, fishing line, high-performance sails, suspension lines on sport parachutes and paragliders, etc. Also, Kurtz (2004) says UHMWPE has a clinical history as a biomaterial for use in hip, knee, for spine implants, joint replacement, etc.

Besides its strength, according to Wong et al. (1994), UHMWPE is odorless, tasteless, and nontoxic. So, when it dissolves inside the asphalt mixture, it won’t give any toxic chemicals, like the other Polyethylene do. Tong et al. (2006) also mention that it is highly resistant to corrosive chemicals. It has extremely low moisture absorption and a very low coefficient of friction.

3.2. Adding UHMWPE into Asphalt Mixture

Cited from Venture Magazine (2020), Being mixed with plastic, lowers the temperature of poured asphalt, reducing emissions. The resulting roads can withstand more extreme temperatures without cracking, reducing the number of potholes. The more flexible roads should also last longer than traditional asphalt roads. They do not absorb water, have better flexibility which results in less rutting and less need for repair. Road surfaces remain smooth, are lower maintenance, and absorb sound better.

The advantages of UHMWPE are better than any other polyethylene. Some researches already conducted about bitumen that made from plastic waste. However, based on Stronglylis article, plastic is non-biodegradable, and burning these plastics cause environmental pollution. Roads made from plastic waste have been criticized in the past as being misleading because of their potential to spread micro-plastics into the environment. Micro-plastics saturate the air we breathe, the water we drink, and the food we eat. Yet, Different from the other, UHMWPE case is better. Burning them into high temperature cause no impact to the environment not like any other polyethylene.

The other main reason is also using the strength of UHMWPE to create better bitumen that can fix some Indonesia's street problem which can't withstand big loads. As to withstand the irregular climate change, based on Zhang et al. (2017), UHWMPE melting point is at around 155 degrees Celsius, and brittle point at -150 degrees Celsius. Which will melt well alongside the asphalt mixture since they share the same melting point.