

Cold in-place recycling with bitumen emulsion

Animesh Das¹

Introduction

The cold in-place recycling (CIPR) is a process where the existing bituminous pavement is recycled without application of heat. In CIPR process the scarified material from the existing pavement is crushed to the required gradation and binder in cold form (emulsion or cutback or foamed bitumen) is added. Externally acquired Reclaimed Bituminous Pavement (RBP) or fresh aggregates are also added depending on the requirement. The material is mixed in-situ, compacted, and left for curing. During this process additives like, cement, quick lime, fly ash are also used. The depth of treatment is typically 75-100mm (MS-19 1998).

The present article briefly discusses the mix design and construction related considerations of emulsion based CIPR process. The advantages and disadvantages of this process are identified and the finally the article is concluded with some closing remarks.

Mix design considerations

CIPR mix design is generally done by Marshall or Hveem method (MS-19 1998). The specimens may be also be evaluated using indirect tensile strength or resilient modulus testing (TFHRC 2005). Various other mix design methods are proposed by different organizations (for example, Oregon, California, Chevron, Kansas, New Mexico methods etc.), which are variations of procedures involving the same basic bituminous mix design principles (FHWA 2002). Superpave based mix design protocol has recently been developed for CIPR (FHWA 2002).

The initial estimate of binder content is obtained from the total binder demand and the binder present in the RAP. The amount of emulsion to be added is calculated from the water to bitumen proportion in the emulsion. While estimating the volumetric parameters due considerations are given towards the possibility of presence of some moisture inside the cured and compacted samples (MS-19 1998).

Construction considerations

A typical CIPR train consists of cold milling machine, screening and sizing (or crushing) unit, and mixing unit. The paving unit could be combined with the mixing unit, or may be a separate one (TFHRC 2005). The lift thickness is decided considering the rate at which water evaporates (MS-21 1998). After about 30 minutes of curing and drying, when emulsion starts breaking (depends on temperature, humidity and wind), the breakdown rolling is initiated with large rubber-tired roller (MS-19 1998). At this stage of rolling, the

¹ Assistant Professor, Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur 208 016, e-mail: adas@iitk.ac.in

moisture is sufficient to act as lubricant between the aggregates, but it does not allow reduction of void or undesirable displacement (MS-21 1998). Intermediate rolling is generally done by a vibratory steel drum roller (TFHRC 2005). Since the CIPR mix is more viscous than conventional hot-mix, heavier rollers are required (Landers 2002). Generally about two weeks of curing is required during favourable weather conditions, and then a suitable seal coat or hot mix overlay is applied (TFHRC 2005).

Advantages of emulsion based CIPR

The CIPR with emulsion takes care of structural improvement without changes in the pavement geometry. This technology corrects most of the types of pavement distresses (e.g. raveling, rutting, corrugation, shoving etc.) (Mosey and Defoe 1979, Landers 2002). Being an in-situ process the hauling cost is considerably low. The air quality related problems during construction is almost negligible as compared to the hot mix process (Mallick 2005). Since this process does not involve application of heat, premature aging of bitumen also can be avoided (Miller group 2005). It is believed that emulsion based recycled pavement is more durable in freeze-thaw situations, compared to hot mix recycled pavement (Landers 2002).

Limitations of emulsion based CIPR

Improper emulsion application can result in high residual bitumen content (leading to flushing) and excessive processing can result in high fines content (leading to rutting due to low stability) (TFHRC 2005). CIPR with emulsion as binder requires some curing period before it can be opened to traffic. CIPR being porous in nature, it essentially requires a seal coat or hot-mix overlay (Landers 2002).

When compared with foamed bitumen based CIPR, emulsion based CIPR has certain limitations. For example, the curing period for foamed bitumen is much lesser than emulsion, since small amount of moisture is used in foamed bitumen. Also, the foamed asphalt is cheaper than emulsion since it does not require any additives (Moore 2004).

Closing remarks

Moisture content needs to be given due importance as it influences gradation control, mixing and workability of recycled mix to a large extent (Mosey and Defoe 1979). With certain kinds of new technology emulsions the curing period can be shortened to three to seven days (Landers 2002). Also, it is found that performance of foamed bitumen based CIPR is very sensitive to smallest size aggregate fraction, whereas it is not so with the emulsion based CIPR (Lewis and Collings 1999). Thus, various issues related to the CIPR can only be resolved through more experience and systematic documentation of various pavement recycling projects.

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