TB - 001

Elastiko[R] ECR
Engineering Crumb Rubber Mix Design
Preparation Guidelines
(March 22nd, 2023)

INTRODUCTION TO ENGINEERED CRUMB RUBBER (ECR)

Elastiko[R] ECR is an asphalt mix modifier. When you add this ECR (Engineered Crumb Rubber) to your mix, it will react with the binder and increase the mix rutting and cracking resistance. The interaction between binder and rubber requires a little time and control of the mix temperature in order to get optimum results. When the ECR is exposed to heated binder, the surface pores of the rubber will absorb the lighter ends of the binder and the rubber grains will swell. At a mix temperature of about 325 F, this reaction will be pretty much complete in about 30 minutes. The ECR binder absorption and added fines will stiffen the mix, and the swollen rubber grains will impede crack development in the mix following compaction.

When you use ECR in production, the rubber is added like RAP in what is called a "Dry Mix" process. The plant mixing process thoroughly coats the rubber grains with binder and permits the rubber-binder interactions to occur in the period between plant mix production and placement on the mat for compaction. When ECR is used in the lab, duplicating the plant mix process in the lab requires some changes in the way mix samples are produced, because unlike mix production with pre-modified binders (as in wet process modification), quality technicians need to make sure that the ECR mix meets the time and temperature requirements of this technology. The ECR lab procedures are outlined below. If you follow them carefully, the mixes you produce in the lab will be similar to the mixes produced in full production. If you skip steps and do not manage the mix temperature and interaction time, your lab mixes will perform poorly and will not behave similarly to plant-produced mixes.

If you have questions regarding these procedures, please call or email us, and we will be more than willing to help you get more comfortable with this process.

INTRODUCTION TO ECR LAB TESTING PROCEDURES

With the understanding that Volumetrics does not fully indicate mix quality - especially with different types of recycled materials used today - the concept of Balanced Mix Design (BMD) can help identify options to meet specific performance requirements. Our ECR offers mix designers a powerful MIX MODIFIER tool when improved mix designs are desired.

The addition of engineered crumb rubber to a range of mix designs - dense-graded,

gap-graded (SMA/OGFC), porous, etc. – can significantly improve pavement performance. In order to support labs and asphalt producers that are unfamiliar with this ECR Dry Mix modification process, Asphalt Plus has prepared this guide to the preparation and evaluation of rubber modified asphalt samples. The sample preparation process outlined below is designed to simulate the material heating, mixing, handling and mix residence times associated with plant production and laydown processes. The sample preparation process also simulates the plant processes that control the uptake of binder into the rubber as well as the associated swelling and softening of the rubber grains during production.

During lab sample development and testing, a failure to follow the procedures in this document may result in the production of samples that are unrepresentative of the volumetric and performance characteristics of plant produced mixes.

Please review this entire document before working with Elastiko^{R} ECR. If you have any questions, please contact us directly. Asphalt Plus is committed to supporting your efforts.

SAMPLE SIZE

When preparing mixes in the lab and in order to produce representative mixes, it is important to maintain sample temperatures so that they mimic the temperature stability of a large mass of heated materials (like mix stored in silos or on truck beds); a condition characteristic of asphalt production operations. In the lab, it is critical to use samples of at least 6000 grams (~13 lbs.) in order to maintain the temperature profile during testing.

LAB MIXING METHODS

During the production of asphalt mix samples with Elastiko^{R} ECR, there are two permitted mixing methods that can be used: Shear mixing of rubber and binder together before mix production, and use of a lab scale heated pug mill to mix heated binder, aggregate and Elastiko^{R} ECR. Shear mixing is most common. The following guidelines are developed specifically for the shear mixing method. If you intend to use a lab-scale pug mill, please contact us for slightly different mixing instructions. ***Please note that simply dumping heated binder, aggregate and Elastiko ECR into a bucket mixer will produce unsatisfactory mix performance testing results.***

Shear Mixing Instructions

1. Select a base mix design for the planned application.
2. Select the binder grade for the mix design.
3. Calculate the amount of ABR planned for the mix.
4. Calculate the amount of virgin binder for the mix (total binder less ABR).
5. Calculate the amount of Elastiko^{R} ECR required in the mix (for an approximate 2grade bump equivalent, use 10% by weight of the virgin binder).
6. Calculate the supplemental binder that needs to be added due to the absorption into Elastiko^{R} ECR. For each 5 lbs. of rubber added to a mix ton, increase the virgin binder content by 0.1%. (Note: 0.1% is a general guidance number. Binder uptake by rubber can vary somewhat based on binder quality. Supplemental binder additions may vary in Fine vs. Coarse Dense-Graded mixes and with the levels

of ABR% allowed by various state highway agencies. Supplemental binder additions should be determined by the volumetric test of JMF.) **NOTE: Fine dense grade mix designs without RAP will only require 0.1% supplemental binder for JMF.**

7. Assemble the aggregate, RAP, RAS, Elastiko^{R} ECR and binder necessary for the test mix samples. (The Elastiko^{R} ECR and supplemental binder quantities are added *on top* of the base mix design. See note at end of this bulletin for calculation guidance).
8. Pre-heat the aggregate to between 325-350F (163 to 177C) (preferably 350F) and maintain the temp.
9. Pre-heat the binder to 325F, and then add the correct proportion of Elastiko^{R} ECR to the preheated binder. If the mix design uses 10% ECR additions by weight of virgin binder, then the addition of crumb rubber for shearing should be 10% by weight of the heated binder sample.
10. Slowly add Elastiko^{R} ECR to the binder kept in a high-speed, shearing mixer (~3500 rpm). Allow a total mixing time of 30 minutes at high shear. Note that the 30-minutes includes the time taken to add rubber in binder (use about 5 minutes for adding rubber to binder). Maintain the binder at 325F throughout the shear mixing process. Also note that the RPM of the shearing machine can be adjusted based on the quantity being sheared. Care should be taken to not introduce significant amounts of air into the binder during the mixing/shearing action (visually look for and avoid the formation of a large vortex while mixing/shearing to prevent entrapment of air bubbles in binder).
11. Preheat the sample molds to 325F (163C).
12. Preheat the forced-draft oven to 325F (163C) for sample conditioning immediately after mixing.
13. Place the mixed binder & Elastiko^{R} ECR into the pre-heated aggregate and thoroughly combine in a bucket mixer. Make sure the aggregate and binder are thoroughly mixed, but do not mix the materials so long that the temperature of the mix drops substantially. We recommend mixing for 2 minutes.
14. Immediately add the sample into the preheated 325F (163C) oven and short-term age for two hours in order to create specimens for volumetric determinations (G_{mm}, G_{mb}).
15. Stir the mix again in order to evenly distribute all of the aggregate particles and then follow approved splitting techniques to create the required G_{mm} and gyratory-compacted G_{mb} or performance testing specimens. This is accomplished by using the prescribed number of design gyrations (Ndes) for the mix type being produced, or in the case of performance specimens, the required number of gyrations to arrive at the target air void level (some iterations may be needed to determine this number).
16. In the event that samples are used for further mix analysis (crack and rut testing), sample preparation for testing should begin after the completion of the two hours of oven time referenced in step 14 above. For performance testing requiring two hours of short-term oven aging,

compaction can directly follow the two-hour short- term aging stage, as described above. If a 4-hour total conditioning time is required prior to performance testing, then the first of four hours can be set at 325F (163C) and rest at the typical conditioning temperature as dictated by prevailing agency specifications.

17. When transferring the prepared sample material from mixing pans to the molds, take extra care to get all – especially the smallest – mastic deposits and small particles transferred into the molds, or desired densities may not be achieved.
18. For mix designs with less than 15% rubber by weight of virgin binder, it is important to keep the compacted mix in the mold for 15- 20 minutes for cooling under a weight of 17-20 lbs., preferably under a fan to facilitate cooling. This prevents the samples from experiencing any swelling.
19. In cases where >15% ECR is used by weight of virgin binder, the post-compaction weight and time can be increased to 25-30 lbs. and 30 mins, respectively. Cooling under a fan can be employed. An application of a release agent on the inner walls of the gyratory compactor can facilitate the removal of the samples from the molds postcompaction, if deemed necessary during the initial lab mix preparation.

Elastiko ECR, Binder & Supplemental Binder Calculation Example

Calculation of the weight of total mixed binder to use in a sample mix design is accomplished by adding the mix design amount of virgin binder, the calculated weight of Elastiko^{R} ECR and the calculated weight of supplemental binder together. For example, to achieve a two-grade bump equivalent of a Job mix design with 6% virgin binder content, you would need 120 lbs. virgin binder (6% of 2000 lbs.), 12 lbs. of Elastiko^{R} ECR (10% of the virgin binder weight of 120 lbs.) and
4.8 lbs. of supplemental binder (0.1% (of mix weight) extra binder per 5 lbs. of ECR;
0.1*(12/5) % = 0.24% (of mix weight) extra binder for 12 lbs. of ECR; 0.24% of 2000 lbs = 4.8 lbs.).
(Note: Supplemental binder content may vary depending on the ABR% used in the mix design, the quality of the binder and the aggregate gradation in the mix design. Supplemental binder additions should be determined by the volumetric test of JMF.)

NOTE: WHEN PERFORMAING SAMPLING AND TESTING FROM PRODUCED PLANT MIX, ENSURE EACH SAMPLE HAS AT LEAST 30 MINUTES AFTER PRODUCTION BEFORE ANY TESTING IS STARTED. THIS ENSURES THAT THE ECR WILL ABSORB ALMOST ALL OF THE LIGHTER ENDS FROM THE BINDER AND OPTIMIZE SWELLING.