Superpave Binder Materials Selection Procedures

Superpave criteria for choosing a binder is a process which includes project location (climate), confidence level selections for both high and low temperatures, and possible up-grades for traffic speed (fast, slow or standing) and traffic volume. Specifications for all hot mix asphalt (HMA) products (Items 340, 341, and 344) require selection of a performance graded (PG) binder. Porous friction course (PFC), Item 342, and stone matrix asphalt (SMA), Item 346, require the use of either PG 76 or Asphalt Rubber.

Phase I - Base Binder Grade

Select the beginning binder based on the location (climate) and confidence levels (the chance that normal variations in temperature will not exceed your binder's grade range). The selection algorithm uses this information and heat transfer calculations to determine a binder grade based on the pavement temperatures expected in the surface layer (actually 20 mm below the surface). In practice, this involves using a computer program for individual locations or maps developed for larger data sets showing climate grades in geographic areas.

- ***Computer Program*** **-** The computer program (pgexcel3) uses input of longitude, latitude, high and low temperature confidence to calculate the binder grade required. The computer program allows individual entry of the high and low temperature confidence levels from 50% to 99.99%. These confidence limits are the percent chance that local climatic temperature variations will not exceed the design temperatures. The program output is the PG binder that meets the defined minimum confidence limits for the closest three weather database stations. These are the standard climate grades for the three locations and represent the binder required for fast moving traffic.

  Determining the base binder grade should include studying the effect of the confidence limit on the high and low temperature portions of the grade. In general, the high temperature part of the grade will not change unless one reduces the confidence significantly. This will probably result in unacceptable confidence levels. The low temperature part of the grade might change with modest decreases in confidence levels. The district should choose confidence levels they can support.

- ***Maps –*** Construction Division, Materials & Pavements Section (CST-M&P) supplies maps at 95% and 98% confidence levels that were generated using the computer program. These maps are color coded according to PG binder grade by county.

Phase II - Possible High Temperature Designation Increases

In theory, only the temperature (how cold does it get), and not traffic levels or mixture type, affects low temperature binder performance (resistance to thermal cracking). The high temperature designation can be influenced by factors other than climate, as described below.

- ***Speed and Volume*** **-** The high temperature performance, resistance to rutting, is affected by several traffic related factors. The Superpave system allows one to increase the high temperature grade for traffic speed and volume.

The designation of the initial climate-based binder grade assumed that a fast loading rate, this means it assumed fast moving traffic. Slow moving traffic (longer loading times) may warrant an increase of one temperature grade on the high side. Standing traffic (higher loading times) may warrant increasing the high temperature grade by two increments over the base climate grade.

There are also recommendations for increasing the high temperature designation for traffic volumes. Traffic volumes are described by number of 18,000 lb. equivalent single axel loads (ESALs) expected over the design life of the pavement structure (typically 20 or 30 years) to account for the higher pavement loads from trucks, and not by traffic counts which treat all vehicles the same. The recommendations are: 1) If the design life of the pavement will see more than 10 million ESAL's, consider increasing the high temperature designation by one (1) grade, and 2) If the design life of the pavement will see more than 30 million ESAL's, increase the high temperature designation by one grade. Notice that this is not a two-grade increase for over 30 million ESAL's. In summary, the guidance is: above 10 million ESALs consider an increase, and above 30 million ESALs you should definitely increase the grade one increment.

- ***Engineering Judgment*** - When determining the appropriate base binder grade and considering possible increases to the high temperature grade, there are some economic considerations as well.

  The TxDOT specification for PG binders includes a test called Elastic Recovery (ER) for any binder with a temperature grade span of 92 or more. This ER requirement gets higher for increasing grade span. This requirement effectively requires the use of an elastic polymer additive in the manufacture of the binder. Polymers add cost (materials and processing) to the base binder and result in increased price. The higher the grade span, the more polymer, and generally a higher price.

  Use judgment in the number of high temperature "bump-ups." One could come up with a scenario in which a base climate grade of PG 64-22 is bumped three or four times resulting in a PG 82-22 to be specified for a project. This would probably be overkill and would result in a very expensive binder, which also may be difficult to place. A maximum 2-grade increase is usually sufficient in all but the most extreme conditions.

  The selection process, using weather data, assumes you are selecting the binder for a surface layer (actually 20 mm below the surface). Deeper in the pavement structure the binder is not exposed to the same temperature extremes as the surface; therefore, multi-layer paving projects can use less demanding binder grades in lower layers. Lower layers generally do not need bump-ups for the high temperature grade and the further from the surface they are, they can use lower high temperature grade binders than the standard selection process indicates. (For example: If you were building 3 layers and PG 64-22 is indicated as the standard climate grade and you are on high volume facility, you might use PG 76-22 for the surface, PG 64-22 for the middle layer and PG 58-22 for the lowest layer.)

Another consideration is the number of binder grades specified in a project. Requiring the use of multiple binder grades may influence a contractor's ability to store binder and produce HMA. Using two binder grades in the same time frame is considered reasonable.

In the TxDOT specification, a specific binder grade meets all the requirements for that grade and all lesser performing grades. This means that a PG 64-22 meets the requirements for PG 58-22, PG 58-16, and PG 64-16. These grades usually will not require polymer additives in their manufacture and consequently will not have much if any price difference between them. Therefore, in the multiple layer example above, you might use a PG 76-22 for the surface and a PG 64-22 for all underlying layers to both meet your design and economical considerations without requiring too many grades for the contractor to store. For a single layer project, if the climate showed you need PG 64-16, you may specify a PG 64-22 (theoretically a better performing grade) and expect little to no added binder cost.

Contact Information

If you have any questions about the use, suitability, or selection of PG binders, please contact Jerry Peterson, P.E. (512-506-5821) or Darren Hazlett, P.E. (512-506-5816).