# Design and Construction Guidelines
# Type HS/Intersection Mix

The California Asphalt Pavement Association (CalAPA) with assistance from local agencies, Caltrans, and Nevada DOT, have developed this high stability intersection mix (Type HS). CalAPA has received many inquiries into the need for a rut resistant mix to address severe rutting at intersections. The rutting primarily showed itself in the area before the stop bars. This rutting can be attributed to the deceleration and acceleration of traffic which includes automobiles as well as large trucks. The addition of heavy truck traffic in these areas tended to increase the distresses experienced.

CalAPA formed a task group (Intersection Mix Committee) which included participants from industry, local agencies, Caltrans , and Nevada DOT (NDOT). The group worked on developing a strategy that would address the rutting problem and at the same time minimizing the cost, and production/construction concerns. The task group identified the need to utilize fundamental concepts identified in the Superpave program while minimizing the change from how hot mixed asphalt (HMA) pavements are currently designed and constructed. In essence the Type HS mix has included the following concepts. The aggregate quality has been increased through the increase in fractured faces required. The gradation of the mix is based on the voids in mineral aggregate (VMA) and the voids filled by asphalt (VFA). Both design and construction utilize theoretical maximum density for air voids and density determination. An important design parameter included in the Type HS mix is a second tier stability requirement. The current Caltrans mix design procedure requires the Hveem Stabilometer test (CT 366) be run using 150 tamps at 230°F. While this may be acceptable at the completion of pavement construction, the committee wanted to make sure that the pavement structure does not collapse under several years of high traffic loading. As a result, the task group decided to require the mix to be able to have a stability value of 35 or more using CT366 with an additional 500 tamps and decreasing the testing temperature to 140°F.

Once the mix design requirements were completed, the mix was tested by NDOT utilizing the asphalt pavement analyzer (APA) to assess the rutting characteristics of the mix. This was compared to Caltrans standard mix and NDOT mix. The Type HS mixes were designed utilizing AR8000, PBA6a*, and PG76-22NV binders. The Type HS mixes showed an increase in rut resistance from 20-40% over Caltrans standard mixes. While the Type HS mixes utilizing modified binders show a significant increase in rut resistance, the Type HS mix utilizing AR8000 exhibited adequate rut resistance for most applications.

The City of Los Angeles tested the Type HS for rut resistance using the Repetitive Wheel Loading Device. Both ½" and ¾" mixes were evaluated utilizing PBA6a* and PG76-22NV binders. After the samples were prepared using the Superpave gyratory compactor, the lab tested the specimens for AC content, gradations, theoretical maximum specific gravity, bulk specific gravity, permanent deformation and Marshall stability. The Type HS mixes showed strong resistance to rutting. The City of LA's extensive research and experience show that a rut resistant mix should not exceed 3.5mm in deformation. The Type HS mixes ranged between 0.7mm and 2.0mm and can be classified as a high stability mix. Also noted was essentially no difference between the rut resistance of the ½" and ¾" Type HS mixes Since the initial testing by the Intersection Mix Committee Caltrans has changed the asphalt binder specifications from the AR grading system to the PG grading system. The recommended binder grades identified in these guidelines and the specification should approximate the results achieved in the testing.

When the Type HS mix is specified, it is important that the entire pavement section is designed and constructed correctly or the benefits of the high stability mix may be lost. The following guidelines are recommended when specifying Type HS mix.

## *DESIGN GUIDELINES*

While the initial intent of the mix was for intersection use, this does not preclude its use in mainline, on/off ramp, and bus stop applications.

The mix may cost more than conventional mix. This may result from material costs (higher quality aggregates and binders), production (not the standard mix and may require HMA plant dedication), and construction costs. To minimize the costs the project should include daily paving quantities near 1000 tons. It may be beneficial to include several intersections or mainline paving between intersections.

Should the HS mix be utilized in an intersection application, the following should be considered:

- HS Mix should be used from the end of the queue through the intersection to a point at which the anticipated speed has been achieved. The pavement experiences the highest stresses during slow speeds, allowing longer tire contact on each section of pavement (this is evident where rutting is greatest behind the stop bar and continues through the intersection as vehicles increase speed).
- In order to minimize handwork and promote continuous paver runs on the main line, side street conforms should not be specified for minor residential streets with stop signs. Where conforms are used, paving should be carried a minimum of 100' into the side street**.**

Selection of Type HS thickness for repairing existing pavements should be based on an analysis of existing subgrade and base course strength and the condition of the existing AC. As a starting point, the minimum design thickness of pavement section utilizing the HS Mix should be a minimum of 3 inches**.** The stresses from traffic affect the pavement through the first four inches of the pavement section. Every effort should be made to remove the distressed HMA at least two inches below the bottom of the rut for the full lane width.

The binder that should be used with the HS mix is the PG 70-10 (based on the Caltrans PG binder selection criteria and found in the Caltrans Standard Specification Section 92). In circumstances where very heavy truck and/or bus traffic is expected (i.e. entrances to industrial facilities, transit transfer stations, etc.), consider specifying a polymer modified binder, PG 64-28PM or PG 76-22PM**.** Also, in cool, high elevation locations, consider using the PG 64-28PM. Note that the polymer modified binder types may not be available at all times which may affect the material and placement price. It is imperative that the agency check with the industry to determine availability.

Omit paving fabric 200 feet before intersections and at ends of off-ramps.

## *CONSTRUCTION GUIDELINES*

Hold a pre-construction conference (agency, contractor & AC mix supplier) to review the Type HS specification and construction guidelines.

RAP can be used in the HS mix. The design should allow the use of RAP. If the Contractor uses a RAP percentage of 15% or less, no additional binder testing is required. If the Contractor proposes using more than 15% RAP, an analysis of the effect on the virgin binder needs to be conducted in-line with the FHWA guidelines.

Since the HS mix is "coarser" it is prone to segregation and rock pockets. When using bottom dump trucks with a pick-up machine, the contractor should avoid dumping of the paver wings when the hopper is less than one half full. Requiring the use of "fillet plates" in the hopper should be considered by the Contractor. (Also see recommendations re. conforms above.)

As a result of the coarse gradation and the binder type, the HMA mix becomes sensitive to temperatures. It is important that the environmental conditions are monitored to ensure an adequate environment for paving. The air temperature, ground temperature and wind speed must be checked and a determination needs to be made while also considering the lift thickness being placed. Using a program like the Multicool program available through the University of California Pavement Research Center (UCPRC) would be beneficial to determine if there is adequate time for the contractor to properly compact the mixture. A good rule of thumb is that the contractor should have 25 minutes before the pavement temperature drops below 175F

The density of the in-place pavement is critical to the long term performance of the intersection mix. Measuring the density of the pavement is achieved through the use of non-destructive density devices or cores. If using a non-destructive density device, the device needs to be correlated to cores and the testing should include a minimum of 10 tests per 500 tons. If using cores, the testing should include a minimum of 2 cores per 500 tons. All test locations should be determined by an appropriate random sampling method.

When specifying the relative compaction of the pavement, specify a minimum 96% of the laboratory-compacted reference density determined on a daily basis. This should be based on the average of the number of tests (cores or gauge readings per sublot).

When specifying the density of the pavement, specify a minimum of 91% of theoretical (Rice) maximum density determined on a daily basis.

Minimum lift thickness for construction should be 4 times nominal maximum aggregate size. This is necessary to ensure the space required for the aggregates to orient themselves to achieve the required density.

Rubber-tired (pneumatic) rollers should also be required.

Allow HMA to cool to 150F max before first heavy vehicle (buses or trucks) traffic.