Caltrans Survey on Crumb Rubber Modifier (CRM) Verification

Compiled by Phil Stolarski, California DOT

August 11, 2014

Backgroud Info:

The California Department of Transportation (Caltrans) is interested in how you deal with CRM verification.

Info. Requested by Month day, 2014:

1. Does your state specify a minimum amount of Crumb Rubber Modifier (CRM), consisting of scrap tire/waste tires, in any of the asphalt binder used for pavement?
   a. Yes, Minimum of ____% **b**. No

2. Does your state have a procedure to verify the (source and/or amount of) CRM in asphalt binder?
   a. Yes **b**. No

3. Does the verification procedure with respect to the amount of CRM in asphalt binder include:

   1. Analytical (ie: Fourier Transform Infrared Spectroscopy-FTIR, Thermogravimetric analysis-TGA, Size-Exclusion Chromatography-SEC, etc)
      a. Yes
      b. No
   2. Weights and Measures (calibrated equipment with data recording, weighmaster, etc)
      a. Yes
      b. No
   3. Chain of custody of CRM (Bill of Lading, report, etc)
      a. Yes
      b. No
   4. Others, please describe_____

4. Does the verification procedure with respect to the source of CRM in asphalt binder include:

   1. Weights and Measures (calibrated equipment with data recording, weighmaster, etc)
      a. Yes **b.** No

   2. Chain of custody of CRM (Bill of Lading, report, etc)
      a. Yes **b.** No

   3. Others, please describe

5. Please provide direction/link to available document or website related to CRM verification in asphalt binder.

State	Comments	Contacts
AR	Arkansas does not allow crumb rubber modifier.	Michael C. Benson Email: Michael.Benson@ahtd.ar.gov
CA	**1.** a. Yes. Minimum of 18% for asphalt rubber binder and minimum of 10% for PG-M binder. **2.** b. No. **3.** **1.** No. **2.** No. **3.** No. **4.** No response. **4.** **1.** No. **2.** No. **3.** No response. **5.** Not applicable.	Kee Foo Senior Transportation Engineer (Specialist) Office of Asphalt Pavement Pavement Management Program Division of Maintenance 2389 Gateway Oaks, Suite 200 Sacramento, CA 95833 Phone: 916-274-6077 Email: Kee.Foo@dot.ca.gov
CO	**1.** No. **2.** No. **3.** **1.** No. **2.** No. **3.** No. **4.** No response. **4.** **1.** No. **2.** No. **3.** No response. **5.** CDOT does not specify the modifiers that are to be used in our asphalt binder. Some suppliers choose to use crumb rubber but it is not mandated. We test the binders for DSR, Viscosity, RTFO, etc... We are concerned that it meets our specifications, no necessarily what process they used to get there - with one exception... we do not allow acid modified AC at this time. Below is the link to our Asphalt Binder Specification - specifically look at section 702 Bituminous Materials http://www.coloradodot.info/business/designsupport/construction-specifications/2011-Specs/2011-specs-book/section%20700.pdf/view	Michael Stanford Email: Michael.stanford@state.co.us

State	Comments	Contacts
CT	**1.** Not a lot to offer just some thoughts below. Connecticut has not specified CRM in any projects yet. Our legislature has identified recycled asphalt shingles as our current green initiative. I have no doubt we will be looking at CRM in the near future. **2.** No, but it would probably be a certification for the source. To verify the amount I guess that would depend on what quality control methods the producer of the asphalt and/or binder used. Our QA process should be aligned with their quality control. **3.** No response. **4.** No response. **5.** No response.	Robert G. Lauzon Principal Engineer (Materials) Connecticut Dept. of Transportation Division of Materials Testing 280 West Street Rocky Hill, CT 06067-3502 Phone: 860-258-0312 Fax: 860-258-0399 Email: Robert.Lauzon@ct.gov
FL	**1.** Yes. Minimum of 7%. **2.** No, not specifically. The producer must certify on their bills of lading that a minimum of 7% ground tire rubber had been used to make the binder and purchase and shipping records are reviewed during facility inspections. The records must also show that the producer is using a ground tire rubber from the State's Qualified Product List. **3.** **1.** No. FTIR is used for forensic purposes only, not for verification. **2.** No. Records are looked at during random inspections of the facilities, but not specifically for verification; more for program compliance. **3.** Yes. **4.** No response. **4.** **1.** Yes. **2.** Yes. **3.** Testing records, observed split samples. The equipment and process is observed to ensure compliance with the FDOT process. Sampling bags (super-sacks) for the CRM are inspected for proper labeling and storage. **5.** http://www.dot.state.fl.us/specificationsoffice/Implemented/WorkBooks/JulWorkbook2014/Default.shtm#ss Please see sections 916 and 919 for the appropriate specifications.	Tanya Nash Bituminous Engineering Specialist State Materials Office, FDOT 5007 NE 39 Avenue Gainesville, Florida 32609 Phone: 352-955-2903 Fax: 850-412-8032 Email: Tanya.nash@dot.state.sl.us
GA	**1.** Yes, a minimum of 7% must meet phase angel requirements or 10%. Otherwise no. **2.** Yes. **3.** **1.** No. **2.** Yes. **3.** Yes. **4.** No response. **4.** **1.** No.	Peter Wu Technical Assistance Office of Materials Phone: 40-608-4840 Email: pwu@dot.ga.gov

State	Comments	Contacts
GA (cont.)		

2. No.
3. No response.

5. Our CR spec is on Page 1133 of the spec book.
http://www.dot.ga.gov/doingbusiness/TheSource/specs/DOT2013.pdf
An example of asphalt plant CR amount verification is listed below:

Crumb Rubber (CR) Usage Inventory Worksheet

Project Number	CSSTP-000-7-00(183)

County	Colquitt

CR % of AC	8.00
Required Total CR+TOR	8.360

% OF TOR	**4.5**	**TOR % CR***	**0.360**

* Currently 4.5% of CR is Required

Date	Tons of Mix Produced	Mix Type	Avg. AC Content (159)	Total lbs. CR/TOR Used	Calculated Actual % CR + TOR USED	Calculated % CR + TOR Required	Calculated Deviation From Target Required CR
5/30/14	775.85	12.5 sp	5.42	7351.0	8.741	7030.9	4.552
5/31/2014	1218.76	12.5 sp	5.53	11114	8.245	11268.8	-1.374
2-Jun	1547.59	12.5 sp	5.58	13885	8.039	14438.6	-3.834
6/3/2014	1397.59	12.5 sp	5.49	13314	8.676	12828.9	3.782
6/9/2014	1859.12	12.5 sp	5.42	17184	8.527	16847.8	1.996
6/10/2014	1737.4	12.5sp	5.56	16352	8.464	16151.4	1.242
6/11/2014	1323.25	12.5sp	5.38	11814	8.297	11903.1	-0.749
6/12/2014	1798.92	12.5sp	5.49	15572	7.884	16512.8	-5.697
6/13/2014	804.4	12.5sp	5.56	7509	8.395	7478.0	0.415
6/23/2014	1333.74	12.5sp	5.57	12300	8.278	12421.2	-0.976
6/24/2014	1077.72	12.5sp	5.45	9859	8.393	9820.6	0.391
6/25/2014	1144.3	12.5sp	5.65	10911	8.438	10810.0	0.935

State	Comments	Contacts
GA (cont.)	6/26/2014 938.2 12.5sp 5.42 8969 8.819 8502.2 5.490 7/11/2014 921.58 12.5sp 5.19 8444 8.827 7997.2 5.587 7/14/2014 1494.65 12.5sp 5.4 14094 8.731 13494.9 4.439 7/15/2014 728.77 12.5sp 5.38 6563 8.370 6555.5 0.114	
IN	We are interested in the use of CRM in asphalt binder; however, we have not allowed CRM to date and are studying the possibility of use for 2015. We would be very interested in receiving the results of your survey.	Ronald P. Walker, Manager Office of Materials Management Indiana Department of Transportation 120 S. Shortridge Road Indianapolis, IN 46219-0389 Phone: 317-610-7251 x 204 Fax: 317-356-9351 Email: RWALKER@indot.IN.gov
IA	**1.** No. **2.** No. **3.** Not applicable. **4.** Not applicable **5.** Not applicable.	Jeffrey D. Schmitt, P.E. HMA Field Engineer Iowa DOT – Office of Construction & Materials Phone: 515-239-1013 Email: Jeffrey.Schmitt@dot.iowa.gov
KS	KDOT does not use CRM in asphalt binders, and KDOT does not have a verification procedure to determine the source and/or amount of CRM.	Blair T. Heptig Materials Field Engineer Kansas Department of Transportation Bureau of Construction & Materials 700 SW Harrison, ESOB 7th Floor Topeka, KS 66603 Phone: 785-296-1198 Cell: 785-640-2042 Email: blairh@ksdot.org

KY	**1.** No.
	2. No.
	3.
	  1. No.
	  2. No.
	  3. No.
		Tamara L. Bumgardner
		Liquid Asphalt Section Supervisor
		Division of Materials
		Kentucky Transportation Cabinet

State	Comments	Contacts
KY (cont.)	**4.** No response. **4.** **1.** No. **2.** No. **3.** No response. **5.** Not applicable.	1227 Wilkinson Blvd. Frankfort, KY 40601 Phone: 502-564-3160 Email: Tamara.Bumgardner@Ky.gov
LA	**1.** No. **2.** No. **3.** **1.** No response. **2.** No response. **3.** No. **4.** No response. **4.** **1.** No response. **2.** No response. **3.** No response. **5.** We specify pg 82-22 rm. And require max 30 mesh rubber. It typically requires 11 % crm to meet this. Blended at contractor's plant.	Chris Abadie Email: Chris.Abadie@LA.GOV
ME	**1.** No. **2.** No. **3.** No response. **4.** No response. **5.** No response.	Richard Bradbury Email: Richard.Bradbury@maine.gov
MD	**1.** No. **2.** No. **3.** Not applicable. **4.** Not applicable. **5.** Not applicable.	Barry Catterton Chief, Asphalt Technology Division MD State Highway Administration Office of Materials Technology 7450 Traffic Drive Hanover, MD 21076 Phone: 443-572-5051 1-866-926-8501 Fax: 410-787-0486

State	Comments	Contacts
MD (cont.)		Email: BCatterton@sha.state.md.us
MA	**1.** Yes, minimum of 15%. For our ARGG mix. See attached specification on last page. **2.** No. **3.** **1.** No. **2.** No. **3.** No. **4.** No response. **4.** **1.** No. **2.** No. **3.** No response. **5.** See attached specification on last page.	Bryan Engstrom MassDOT-Research & Materials 400 D Street So. Boston, MA 02210 Phone: 617-951-0626 Email: bryan.engstrom@state.ma.us
MN	No CRM in Minnesota.	Curt Turgeon Metro Maintenance Engineer (Acting) Waters Edge Building 1500 W. County Road B-2 Roseville, MN 55113 Phone: 651-234-901 Email: curt.turgeon@state.mn.us
MO	**1.** No. **2.** No. **3.** **1.** No. **2.** No. **3.** No. **4.** Missouri allows asphalt binder to be modified with GTR. The GTR is incorporated into the binder by the HMA producer. They are responsible for testing the binder to ensure it meets the desired grade. Missouri takes daily binder samples and randomly selects samples for testing. If issues are detected the remaining samples are tested. The approved Job Mix Formula specifies the amount and source of GTR. A chemical link additive called Vestenamer is required to be used with GTR. Only a few contractors have utilized GTR in the asphalt binder. Shown below are the dosage ranges used to date:	Brett Trautman, P.E. Physical Laboratory Director Construction and Materials Division Missouri DOT Phone: 573-751-1036 Cell: 573-690-4070 Email: Brett.Trautman@modot.mo.gov

State	Comments	Contacts
MO (cont.)	• Achieve PG 76-22 è PG 64-22 plus 8 to 9% GTR plus 4 to 4.5% Vestenamer • Achieve PG 70-22 è PG 64-22 plus 5.5 to 6.5% GTR plus 4 to 4.5% Vestenamer **4.** **1.** No. **2.** No. **3.** See question No. 3. **5.** Not applicable.	
NV	**1.** Yes, minimum of 10%. **2.** No. **3.** No response. **4.** No response. **5.** Contractors certify that they have a min 10% CRM in their binder for our TerminalBlend HMA HMA.	Reid G. Kaiser, P.E. Chief Materials Engineer Nevada Department of Transportation 1263 South Stewart Street Carson City, Nevada 89712 Phone: 775-888-7520 Cell: 775-720-4532 Fax: 775-888-7501 Email: rkaiser@dot.state.nv.us Website: www.nevadadot.com
NJ	**1.** Yes, minimum of 17%. **2.** No. **3.** Not applicable **4.** Not applicable. **5.** No response.	Eileen C. Sheehy, P.E. Manager, Bureau of Materials New Jersey Department of Transportation Phone: 609-530-2307 Fax: 609-530-5158 Email: Eileen.sheehy@dot.state.nj.us
NY	**1.** No. **2.** No. **3.** Not applicable. **4.** Not applicable. **5.** Not applicable. Note: NYSDOT allows the use of Terminal Blend CRM for use on all projects as long as the binder meets the MSCR grade specified in the contract documents and also meet the solubility requirements (99 % passing 600 micron sieve).	Zoeb G. Zavery NYSDOT Materials Bureau POD 51 50 Wolf Road Albany, NY 12232 Phone: 518-485-5277 Email: zoeb.zavery@dot.ny.gov

State	Comments	Contacts
NC	**1.** We are in the process of developing our specifications to allow CRM use in NC. We have a specification but haven't placed any material as of yet ad we are very interested in the results of your survey. I've tried to answer to the best of my ability but with our limited (zero) use, I'm afraid it won't be helpful. Todd Whittington is our Asphalt Services Engineer so I've copied him on my response in case you have follow up questions. Hope to see you in Phoenix for NTPEP or in Pittsburg next year for SOM. Yes, minimum of 10%. **2.** Yes. **3.** **1.** No response. **2.** No response. **3.** No response. **4.** We accept a supplier's certification. **4.** **1.** No. **2.** No. **3.** No response. **5.** See below: 11/28/2012 Section 1020-2 [new section defining GTR requirements to be inserted to Section 1020-2 of the Specifications] **Ground Tire Rubber (GTR) Modifier** Produce PG 76-22(RM) modified with Ground Tire Rubber (GTR) by processing automobile and/or light truck tires by ambient grinding methods. Heavy equipment tires, uncured rubber, or devulcanized rubber shall not be used. The GTR must be free of any loose metal particles or other contaminating materials. Metal particles fully embedded in the GTR particles are acceptable. To reduce sticking and caking of the GTR particles, a mineral powder meeting AASHTO M 17, may be added, up to a maximum of 4% by weight of GTR particles.	Christopher A. Peoples, PE State Materials Engineer NC DOT Phone: 919-329-4000 Email: cpeoples@ncdot.gov

<table>
<tr><th>State</th><th>Comments</th><th>Contacts</th></tr>
<tr><td>NC
(cont.)</td><td>The GTR must meet the gradation requirements in the table below:

<table>
<tr><th colspan="2">GRADATION OF GROUND TIRE RUBBER (GTR)
(AASHTO T 27)</th></tr>
<tr><th>Sieve Size</th><th>Percent Passing</th></tr>
<tr><td>2.36 mm (#8)</td><td>100</td></tr>
<tr><td>1.18 mm (#16)</td><td>96 – 100</td></tr>
<tr><td>0.600 mm (#30)</td><td>90 – 100</td></tr>
<tr><td>0.300 mm (#50)</td><td>20 – 100</td></tr>
</table>

The GTR shall be terminally blended with neat asphalt to create a uniform PG 76-22 that meets AASHTO M 320. The supplier of the modified asphalt binder will be required to test the binder product a minimum of once per week or per batch, whichever is less, to ensure AASHTO M 320 compliance.
Failure to meet this specification may affect final acceptance of the asphalt concrete mixture.
The modified PG 76-22 must contain a minimum of 10% GTR by weight of the neat asphalt binder. The binder supplier shall add enough trans-polyoctenamer (TOR) to produce a uniformly blended asphalt binder and maintain storage stability at the asphalt terminal, during shipment, and in the asphalt mix plant's storage tanks. (Note: The Materials and Tests Unit may approve other additives or methods to maintain stability of the GTR-modified binder).The GTR-modified binder must be stored in heated, continuously agitated tanks to maintain uniformity prior to delivery to the asphalt mix plant.

The GTR supplier shall certify that each shipment or production lot meets all requirements of this specification. Test data and signed certified test reports shall be submitted in accordance with the NC Dept of Transportation Asphalt Binder QC/QA Program. The GTR supplier must have an experienced technician or engineer that is readily available to assist with troubleshooting any technical issues during production.</td><td></td></tr>
<tr><td>OH</td><td>We do not verify the amount of source of GTR in our PG binder since we only allow GTR to be pre-blended at the terminal.

1. Yes, we call ours GTR, minimum of 10% by weight of neat binder and pre-blended at terminal only (not allowed at the mix plant).
2. No.
3.
1. No.
2. No.
3. Yes, we require some certs and records of traceability.
4. No response.</td><td>Eric Biehl, P.E.
Asphalt Materials Engineer
Ohio Dept. of Transportation
Office of Materials Management
Asphalt Materials Section
1600 W. Broad Street
Columbus, OH 43223
Phone: 614-275-1380
Email:
Eric.Biehl@dot.state.oh.us</td></tr>
</table>

State	Comments	Contacts
OH (cont.)	**4.** **1.** No. **2.** No. **3.** No response. **5.** The first link below are the latest updates from our 2013 spec book, which also contains our updates PG binder specification (702.01). The update includes the GTR requirements that starts on page 52 and points to the last link at the bottom of page 53, which is our Supplemental Specification 887. http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specification%20Files/CMS800_07182014_for_2013.pdf GTR Spec: http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specification%20Files/887_04182014_for_2013.pdf	
OK	We do not use CRM nor GTR in Oklahoma. We tried a few projects several years ago with CRM with a 50% success rate. The biggest problem was homogeneity. If you need more details about our CRM experience or have other questions, please contact me. Note: Website Links below: http://www.okladot.state.ok.us/materials/ http://www.okladot.state.ok.us/c_manuals/specbook/oe_ss_2009.pdf OHDL Test Methods: http://www.okladot.state.ok.us/materials/ohdllst.htm	Kenneth Ray Hobson, P.E. Oklahoma Department of Transportation Materials Division-Bituminous Engineer 200 NE 21st Street Oklahoma City, OK 73105-3204 Phone: 405-522-4986 Cell: 405-323-5669 Text Msg by Email: 4053235669@vtext.com Email: khobson@odot.org
OR	Oregon does not specify crumb rubber, nor do we have any verification process for its use in our binders.	Cole F. Mullis, P.E. Pavement Services Engineer Oregon DOT 800 Airport Road SE Salem, OR 97301 Phone: 503-986-3115 Email: Cole.f.mullis@odot.state.or.us
PA	**1.** No. **2.** Not really. We have Crumb Rubber Modifier additives listed for SMA and for other (ie gap graded) mixes. The Districts typically specify use (gradation) in a project specific special provision. The material must be free of foreign material.	Robert D. Horwhat, P.E. Chief Materials Engineer Pennsylvania Department of Transportation Bureau of Project Delivery

State	Comments	Contacts
PA (cont.)	**3.** **1.** No. **2.** Shown on the Job Mix Formula by weight. **3.** A certificate of compliance from the manufacturer is required. The crumb rubber suppliers are listed in our QPL. **4.** No response. **4.** **1.** No, received solely on certificate of compliance (to gradation). **2.** Certificate of compliance. **3.** No response. **5.** We have two new specifications being developed now – one for dense graded mixes and another for gab graded mixes. We have used CRM on SMA in the past as well to prevent drain down.	Innovations and Support Services Division 81 Lab Lane Harrisburg, PA 17110 Phone: 717-705-3841 Cell: 717-903-3141 Email: RHORWHAT@pa.gov Website: www.dot.state.pa.us
RI	We allow the use of CRM in our Paver Placed Elastomeric Surface Treatment, a thin overlay. We require that they meet a 64E-28 binder grade and if they choose to use CRM they must use a minimum of 12%. For our standard dense graded mixes they could choose to use CRM to make 64V-28 but thus far all of our contractors have chosen to buy binder pre-modified with polymer. **1.** No. **2.** No. **3.** **1.** No. **2.** No. **3.** No. **4.** No response. **4.** **1.** No. **2.** No. **3.** No response. **5.** Not applicable.	Michael Byrne Principal Civil Engineer RIDOT-Materials Rm. 018 Two Capitol Hill Providence, RI 02903 Phone: 401-222-2524x4135 Email: Michael.byrne@dot.ri.gov
SC	**1.** Yes, minimum of 7.0%. **2.** Yes, on suppliers-modifiers QC plan. **3.** **1.** Yes. **2.** Yes. **3.** Yes, I must be documented. **4.** No response.	Cliff B. Selkinghaus Email: SelkinghCB@scdot.org

State	Comments	Contacts
SC (cont.)	**4.** **1.** Yes. **2.** Yes. Must be documented. **3.** No response. **5.** http://www.scdot.org/doing/technicalPDFs/supSpecs/HMAPGBinderSupplemental.pdf	
TN	Tennessee DOT does not currently allow the use of CRM in our asphalt cements. There has been some push by the CRM industry to allow its use though. **1.** No. **2.** No. **3.** **1.** No. **2.** No. **3.** Yes. **4.** Chain of custody on Certificate of Analysis and Bill of Lading as with all modifiers. **4.** **1.** No. **2.** No. **3.** No response. **5.** No response.	Brian K. Egan, P.E. Tennessee Department of Transportation Director, Materials and Tests Division Phone: 615-350-4101 Fax: 615-350-4128 Email: Brian.Egan@tn.gov
UT	**1.** No. **2.** No. **3.** Not applicable. **4.** Not applicable. **5.** Not applicable.	Howard J. Anderson, P.E. Engineer for Asphalt Materials UDOT Materials Division, Box 5950 4501 South 2700 West Salt Lake City, Utah 84114-5950 Office: 801-965-4426 Cell: 801-633-8770 Fax: 801-965-4403 Email: handerson@utah.gov
VT	VT uses little CRM, and in previous surveys has expressed our desire to see it only in terminal blend/refinery blend application for uniformity of product and process control.	Bill Ahearn Email: Bill.Ahearn@state.vt.us
VA	Virginia does not use CRM in any asphalt binder used in pavement at the present time. **1.** Virginia does not use CRM in any asphalt binder used in pavement. We did one experimental project of about one lane mile in length to see how it performed compared to SBS polymer PG 76-22. This study has not been completed yet.	William R. Bailey III, P.E. Assistant State Materials Engineer Phone: 804-328-3106

State	Comments	Contacts
VA (cont.)	**2.** Virginia does not. **3.** No response **4.** No response. **5.** No response.	Cell: 804-350-3142 Email: Bill.Bailey@VDOT.Virginia.gov
WA	**1.** No. **2.** No. **3.** Not applicable. **4.** Not applicable. **5.** No response.	Kurt Williams, P.E. State Materials Engineer WSDOT State Materials Laboratory Phone: 360-709-5410 Cell: 360-701-7094 Fax: 360-709-5588
WV	**1.** No. **2.** No. **3.** No response. **4.** No response. **5.** No response.	Aaron C. Gillispie Email: Aaron.C.Gillispie@wv.gov
WI	**1.** No. **2.** No. **3.** No. **4.** No response **5.** No response.	Steven Krebs Email: Steven.Krebs@dot.wi.gov
FHWA **Turner Fair Banks Research Center**	We are developing a method to measure the amount of crumb rubber in asphalt. We have just submitted a research paper to TRB. We have developed a method for detecting GTR and recycled engine oil bottoms in asphalt binders. We would be pleased to discuss the method with anyone and would welcome the opportunity to analyze field samples of modified binders to help us verify our test method. We have already analyzed over 1,000 samples from State DOTs for waste engine oil residues. This was the original intent of the method. We have since extended it to include ground tire rubber. We have submitted a paper to TRB on the subject. Feel free to give me a call and send samples. We will gladly analyze them for you and share the results with you.	Terry Arnold Senior Research Chemist Federal Highway Administration Turner Fairbank Highway Research Center Office of Infrastructure R&D Pavement Materials Team HRDI-10 6300 Georgetown Pike McLean, VA 22101-2296 Phone: 202-493-3305 Fax: 202-493-3161 Email: Terry.arnold@dot.gov Website: Http://www.tfhrc.gov

State	Comments	Contacts
FHWA **Office of Asset Mgmt., Pavement. and Const.**	The items of GTR verification and the effects/impact of GTR on the PG grading specifications are areas that I am working on for FHWA through our Binder and Mixture Expert Task Groups and our Mobile Asphalt Testing Trailer program in our Office of Asset Management, Pavement, and Construction. At the last ETG meeting we held in April, we saw presentations from several individuals conducting GTR testing and evaluation. There was a presentation from: Frank Farshidi, on the work being conducted by the University of California Pavement Research Center Amir Golalipour, work being conducted by Anton Paar Rheology Emin Kutay, work being conducted by Michigan State University. It looks like they are all reporting issues with our traditional parallel plate DSR testing with GTR and there is a growing consensus that a better geometry for DSR testing GTR binders is the concentric cylinder (cup and bob) geometry. We have worked on two GTR gap graded structural pavement projects in PA and NJ the past several months and have run into a variety of issues fitting the high GTR concentrations 15-20% into the PG system due to difficulties with GTR particle size, improper RTFO ageing, and DSR parallel plate specimen geometry, to name a few. I would be most interested in the responses you receive from this survey and any information about your processes in California to help assist with our efforts. Also, if you have any Caltrans GTR field projects with gap graded mixtures designed with the Superpave Gyratory Compactor that we could use to conduct additional testing and analysis with the Mobile Trailer to help further develop GRT recommendations, please let me know.	Matthew Corrigan, P.E. Asphalt Pavement Engineer Mobile Asphalt Testing Trailer Program Manager Federal Highway Administration Office of Asset Management, Pavement, and Construction 1200 New Jersey Avenue, S.E. HIAP-20, E73 – 465 Washington, DC 20590 Email: matthew.corrigan@dot.gov Website: http://www.fhwa.dot.gov/pavement
MA **(cont.)**	**MASSACUSETTS ATTACHMENTS CONTINUED ON NEXT PAGE (FROM PAGE 7)**	

ITEM 450.8 **HMA Friction Course – (Asphalt Rubber Gap Graded (HMA-ARGG)** **(TON)**

General: HMA Friction Course – Asphalt Rubber Gap Graded (HMA-ARGG) shall consist of furnishing and mixing gap graded aggregate and asphalt-rubber binder and spreading and compacting the mixture. The work under this item shall conform to Section 450 Hot Mix Asphalt Pavement. Where any discrepancy appears between the Item 450.80 Special Provision and Section 450 Hot Mix Asphalt Pavement, Item 450.80 shall govern.

Quality Control: This item is subject to the requirements of Section 450 as a friction course except that field density will be a Quality Assurance requirement. Pay adjustments for Item 450.80 will be calculated for ride quality, asphalt binder content and in place density.

MATERIALS

Base Asphalt:
The base asphalt shall have a PG Grading of PG58-28. The supplier may substitute PG64-28 where needed to meet the requirements of ASTM D 6114 (type II).

Asphalt-Rubber Binder:

The physical requirements for the asphalt-rubber binder shall conform to ASTM D 6114 type II specifications. The minimum percentage of asphalt rubber by weight is 15%.

The reclaimed vulcanized rubber shall be produced primarily from the processing of automobile and truck tires. The rubber shall be produced by ambient temperature grinding processes only.

The specific gravity of reclaimed vulcanized ground rubber shall be not less than 1.10 nor greater than 1.20

Rubber for use in asphalt-rubber binder shall be free of loose fabric, wire and other contaminants except that up to 4 percent (by weight of rubber) calcium carbonate or talc may be added to prevent caking or sticking of the particles together. The rubber shall be sufficiently dry so as to be free flowing and not produce foaming when blended with the hot paving asphalt.

At least two weeks before its intended use, the Contractor shall furnish samples of the asphalt-rubber binder proposed for use on the project. The samples shall consist of 4 one-quart size cans of the asphalt-rubber binder, together with the formulation and the grade of paving asphalt used.

The method and equipment for combining the rubber and paving asphalt shall be so designed and accessible that the Engineer can readily determine the percentage by weight

for each material being incorporated into the mixture.

Equipment utilized in the production and proportioning of asphalt-rubber binder shall include the following:

An asphalt heating tank with hot oil heat transfer to heat the paving asphalt to the necessary temperature before blending with the granulated rubber. This unit shall be equipped with a thermostatic heat control device.

A mechanical blender for proper proportioning and thorough mixing of the paving asphalt and rubber. This unit shall have both an asphalt totalizing meter (gallons or liters) and a flow rate meter (gallons per minute or liters per minute).

An asphalt-rubber binder storage tank equipped with a heating system to maintain the proper temperature of the binder and an internal mixing unit capable of maintaining a homogeneous mixture of asphalt and rubber.

Reclaimed Asphalt Pavement (RAP): The use of RAP will be permitted at the option of the Contractor and provided that the end product is in conformance with the approved job-mix formula. The proportion of RAP to virgin aggregate for the HMA-ARGG mixture shall not exceed 10%

Warm Mix Asphalt: The HMA-ARGG shall be modified using a Warm-Mix Asphalt (WMA) additive capable of lowering compaction temperatures to below 280° F. Warm Mix Asphalt Technology will reduce compactive effort and permit lower production temperatures than conventional hot mix asphalt.

The WMA additive shall be a product listed on the Northeast Asphalt User Producer Group (NEAUPG) website or the WMA additive must be an approved equal. However, no WMA foaming technology will be permitted which requires the mechanical injection of steam or water into the liquid asphalt. The WMA additive must be compatible with polyphosphoric acid modified and polymer modified asphalts and the HMA producer's HMA anti-stripping agents. The WMA additive shall be introduced in accordance with the Manufacturer's dosing rates and approved blending methods.

No warm-mix technologies which involve the mechanical injection of water directly into the asphalt will be considered for this project. Laboratory prepared samples manufactured with and without the WMA additive shall be submitted to MassDOT at least 45 days prior to placement for testing. These samples shall be subject to testing for moisture damage and rutting. Preparation of these samples shall be coordinated with the MassDOT. The WMA Manufacturer shall have an on-site representative at the beginning of paving operations. The Manufacturer's representative shall be available for additional consultation during the remaining HMA-ARGG production.

Mix Design: The specimens shall be prepared in accordance with AASHTO M323 and R35.

Laboratory Trial Mix Formula (LTMF): The HMA-ARGG mix shall conform to the gradation requirements detailed in Table A:

Table A – HMA-ARGG Mix Gradation

Sieve Designation	Percent by Mass Passing	Tolerances
19.0 mm (3/4")	100	± 0
12.5 mm (1/2")	90-100	± 6
9.5 mm (3/8")	83 – 87	± 6
4.75 mm (#4)	28 - 42	± 6
2.36 mm (#8)	14 – 22	± 4
1.18 mm (#16)	-	-
0.075 mm (#200)	0 – 6	± 1

The mix design will satisfy the following criteria:

Property	Criteria
Air Voids	3 - 6 %
Voids in Mineral Aggregates (VMA)	18 - 23 %
Draindown	0.3 % maximum
% Binder content*	7.6 % minimum
PGB Content – Specification limits	±0.4%
PGB Content – Engineering limits	±0.6%

*The specified minimum binder content applies to the LTMF submittal. Specification and engineering limits for LTMFs and Job Mix Formulas (JMF) at (or near) the minimum binder content will remain constant.

The Engineer shall be notified prior to the completion of the Mix Design and have the opportunity to observe the Plant's verification of the Mix Design. The Mix Design shall be submitted to the Engineer for approval at least 30 calendar days prior to production.

The ARGG job mix formula is sensitive to specific gravity and other source properties. The Department may adjust the JMF based on the supplied aggregate source properties. The Contractor may request minor adjustments to the Master Range which will be subject to the review and approval of the Department.

Extraction/gradation tests shall be performed using a calibrated ignition oven.

CONSTRUCTION

After the material has reacted for at least 45 minutes, the asphalt-rubber binder shall be metered into the mixing chamber of the asphalt concrete production plant at the percentage determined by the Engineer.

When batch type asphalt concrete plants are used to produce the rubberized asphalt concrete, the asphalt-rubber binder and mineral aggregate shall be proportioned by weight.

When continuous mixing type asphalt concrete plants are used to produce the rubberized asphalt concrete, the asphalt-rubber binder shall be proportioned by an asphalt meter of the mass flow, coriolis effect type.

Hot Mix Placement:

A Material Transfer Vehicle (MTV) shall be used in the paving operations. A MTV will provide more consistent temperature and contiguous pavement.

The HMA-ARGG shall not be placed with pavement surface temperatures or ambient temperatures below 40° F. Placement and compaction temperatures are subject to change with the use of a WMA additive. Placement at the minimum ambient temperatures is not recommended, because time available for compaction is very limited and leaves no margin for circumstances or error, which often results in inadequate compaction. When feasible it is recommended that the minimum ambient temperature requirement for HMA-ARGG be increased to 50 °F.

Hot Mix Compaction

A minimum of three rollers shall be provided on the project. The breakdown compaction shall be performed immediately behind the paver and as close as safely possible behind the paver. The intermediate compaction shall occur immediately behind the breakdown roller and as close as safely possible to the breakdown roller. The finish rolling may be adjusted as required by field conditions. The rollers shall use an additive (eg. dishwashing detergent) to prevent roller pickup of the HMA.

The HMA-ARGG shall be compacted to 94% of its maximum theoretical density and verified using pavement cores. Pavement cores shall be sawcut for separation from the underlying pavement layer.

Quality Limits for Density	Criteria
Target In-Place HMA Density	94%
Target In-Place HMA Density – Specification limits	Target ±2.5%
Target In-Place HMA Density – Engineering limits	Target ±3.0%

Breakdown compaction of HMA-ARGG shall be performed in the vibratory mode.

METHOD OF MEASUREMENT

The method of measurement shall be as provided in Section 450.

BASIS OF PAYMENT

The basis of payment shall include the WMA and as otherwise provided in Section 450.