September 27, 2011

TO: Members of the MAG Standard Specifications and Details Committee

FROM: Troy Tobiasson, City of Goodyear, Chair

SUBJECT: MEETING NOTIFICATION AND TRANSMITTAL OF TENTATIVE AGENDA

Wednesday, October 5, 2011 at 1:30 p.m.
MAG Office, Suite 200 (Second Floor), Ironwood Room
302 North 1st Avenue, Phoenix

A meeting of the MAG Specifications and Details Committee has been scheduled for the time and place noted above. Members of the MAG Specifications and Details Committee may attend the meeting either in person, by videoconference or by telephone conference call. If you have any questions regarding the meeting, please contact Committee Chair Troy Tobiasson at 623-882-7979 or Gordon Tyus, MAG staff at 602-254-6300.

In 1996, the Regional Council approved a simple majority quorum for all MAG advisory committees. If the MAG Specifications and Details Committee does not meet the quorum requirement, no action can be taken. Several cases are scheduled for action, so your attendance at the meeting is strongly encouraged.

Pursuant to Title II of the Americans with Disabilities Act (ADA), MAG does not discriminate on the basis of disability in admissions to or participation in its public meetings. Persons with a disability may request a reasonable accommodation, such as a sign language interpreter, by contacting Gordon Tyus at the MAG office. Requests should be made as early as possible to allow time to arrange the accommodation.

It is requested (not required) that written comments on active cases be prepared in advance for distribution at the meeting.

MAG Standard Specifications and Details Committee
TENTATIVE AGENDA
October 5, 2011

	COMMITTEE ACTION REQUESTED
1. Call to Order and Introductions	
2. Call to the Audience An opportunity is provided to the public to address the MAG Specifications and Details Committee on items that are not on the agenda that are within the jurisdiction of MAG, or non-action agenda items that are on the agenda for discussion or information only. Citizens will be requested not to exceed a three minute time period for their comments. A total of 15 minutes will be provided for the Call to the Audience agenda item, unless the committee requests an exception to this limit. Please note that those wishing to comment on agenda items posted for action will be provided the opportunity at the time the item is heard.	2. Information.
3. Approval of September, 2011, Meeting Minutes	3. **Review and approve minutes of the September 7, 2011 meeting.**
2011 Cases Scheduled for a Vote	
4. Case 11-13: Replace Manhole Frame and Cover Details 423, 424 and 523 with new updated versions.	4. **Information, discussion and possible action.** Sponsor: Scott Zipprich, Buckeye
5. Case 11-19: Modify Section 340: Detectable Warnings.	5. **Information, discussion and possible action.** Sponsor: Peter Kandaris, SRP with N. Vescio
6. Case 11-22: Revise Sections 325 and 717: Asphalt Rubber Specifications.	6. **Information, discussion and possible action.** Sponsor: Jeff Benedict, AGC
7. Case 11-23: Revise Section 321: Asphalt Concrete Pavement.	7. **Information, discussion and possible action.** Sponsor: Jeff Benedict, AGC
8. Case 11-24: Add new Section 337: Crack Sealing and Crack Filling.	8. **Information, discussion and possible action.** Sponsor: Jeff Benedict, AGC
9. Case 11-29: Revise Section 701 - Aggregates. Move materials to appropriate sections, and clarify types of aggregates. Update all references to Section 701.	9. **Information, discussion and possible action.** Sponsors: Brian Gallimore, AGC, Peter Kandaris, SRP
10. Case 11-30: Update Section 702: Base Material. Revise Section 310: Untreated Base Course.	10. **Information, discussion and possible action.** Sponsors: Brian Gallimore, AGC Peter Kandaris, SRP

11. Case 11-31: Revise Riprap Sections 220 and 703.	11. **Information, discussion and possible action.** Sponsors: Brian Gallimore, AGC Peter Kandaris, SRP, Jeff Hearne, ARPA
12. Case 11-32: Modify Section 309: Lime Slurry Stabilization.	12. **Information, discussion and possible action.** Sponsor: Brian Gallimore, AGC
13. Case 11-33: Revise Section 311: Soil Cement Base Course.	13. **Information, discussion and possible action.** Sponsor: Brian Gallimore, AGC
14. Case 11-34: Revise Section 312: Cement Treated Base.	14. **Information, discussion and possible action.** Sponsor: Brian Gallimore, AGC

Cases Recommended to Carry Forward to 2012

15. Other Carry Forward Cases: Updates and or discussion of any cases planned to carry forward in 2012. They include cases 11-02, 11-03, 11-12, 11-14, 11-16, 11-18 and 11-21.	15. Information and discussion. Various case sponsors.

General Discussion

16. Working Group Reports	16. Information and discussion.
A. Outside Right-of-Way Working Group Report on 9/20/2011 meeting.	A. Outside ROW Chair: Peter Kandaris, SRP
B. Asphalt Working Group Summary of activities.	B. Asphalt Chair: Jeff Benedict, AGC
C. Materials Working Group Summary of activities.	C. Materials Chair: Brian Gallamore, AGC
D. Water/Sewer Working Group Report on 9/20/2011 meeting.	D. Water/Sewer Chair: Jim Badowich, Avondale
E. Concrete Working Group Summary of activities.	E. Concrete Chair: Jeff Hearne, ARPA
17. Additional Committee Meetings Discussion about extending meeting schedule to include November and December Meetings.	17. Information and discussion.
18. Potential Cases for 2012 Discussion about cases that could be brought forward for review in 2012.	18. Information and discussion.

19.	Staff Reports Report on progress of a new 2012 edition of the MAG Specifications and Details Document. Public Works Directors mailing list.	19. Information and discussion.
20.	Open General Discussion Members can report on any items of interest to the committee.	20. Information and discussion.
21.	Request for Future Agenda Items Topics or issues of interest that the Standard Specifications and Details Committee would like to have considered for discussion at a future meeting will be requested.	21. Information and discussion.
	Adjournment	

MEETING MINUTES FROM THE MARICOPA ASSOCIATION OF GOVERNMENTS STANDARD SPECIFICATIONS AND DETAILS COMMITTEE

September 7, 2011

Maricopa Association of Governments Office, Cholla Room
302 North First Avenue
Phoenix, Arizona

AGENCY MEMBERS

Jim Badowich, Avondale
Scott Zipprich, Buckeye
Warren White, Chandler
* Dave Emon, El Mirage
Greg Crossman, Gilbert
Mark Ivanich, Glendale (proxy)
Troy Tobiasson, Goodyear, Chair
Bob Herz, MCDOT
Mike Samer, Mesa
Javier Setovich, Peoria
Syd Anderson, Phoenix (St. Trans.)
Jami Erickson, Phoenix (Water)
Marc Palichuk, Queen Creek
* Rodney Ramos, Scottsdale
Jason Mahkovtz, Surprise
Tom Wilhite, Tempe, Vice Chair

ADVISORY MEMBERS

Jeff Benedict, ARPA
Tony Braun, NUCA
Bill Davis, NUCA (proxy)
Brian Gallimore, AGC
Adrian Green, AGC (proxy)
Jeff Hearne, ARPA
Peter Kandaris, SRP
Paul R. Nebeker, Independent

MAG ADMINISTRATIVE STAFF

Gordon Tyus

* Members not attending or represented by proxy.

GUESTS/VISITORS

Arturo Chavarria, Hanson Pipe and Precast
Art Glover, Flood Control District of Maricopa County
Michael Hook, ACPA
Matt Savage, Ferguson
Niranjan Vescio, Stronggo

1. Call to Order

   Chairman Troy Tobiasson called the meeting to order at 1:30 p.m.

2. Call to the Audience

   No members of the audience requested to speak.

3. Approval of Minutes

   The members reviewed the August 3, 2011 meeting minutes. Jason Mahkovtz introduced a motion to accept the minutes as written. Greg Crossman seconded the motion. A voice vote of all ayes and no nays was recorded.

4. Recommendation for 2012 Chair and Vice Chair

   Mr. Tobiasson said he and Mr. Wilhite have agreed to serve an additional term as chair and vice chair, and was willing to entertain a motion from the body. Warren White moved and Greg Crossman seconded a motion to recommend the current chair and vice chair serve an additional term. A voice vote of all ayes and no nays was recorded. Mr. Tobiasson thanked the membership, and asked members to consider if they would like to serve as a new vice chair the following year, keeping in mind a geographic balance of the officers is requested of MAG committees.

Review of 2010 and 2011 Cases Scheduled for a Vote

5. Case 10-05 – Revise FOREWORD

   Clarify use of the MAG Specifications and Details for Public Works document. Peter Kandaris said there were no changes or comments since the last meeting, and thought it was ready for a vote. Bob Herz moved and Scott Zipprich seconded a motion to approve Case 10-05 as presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

6. Case 11-01: Miscellaneous Corrections

   a. **Case 11-01A – Correct the formula in Table 711-1.** No new comments provided.
   b. **Case 11-01B – Correct percentage in Table 705-1.** No new comments provided.
   c. **Case 11-01C – Correct reference in Detail 212.** No new comments provided.
   d. **Case 11-01D – Correct errors in Detail 262. NEW.** Bob Herz explained that when reviewing alley entrance details for the deletions case, he noticed that Detail 262 could be easily revised to make it compliant with current ADA requirements by adjusting the warped areas. The revised detail made this change. Scott Zipprich asked if the minimum distance was 4’ on the angled part of the sidewalk created by revision. Calculations confirmed that the current 4’ minimum sidewalks in the details would create a pathway greater than the 3’ currently required by ADA. Tom Wilhite asked

how the new recommendations from the access board would affect it. Mr. Herz said that if the recommendations were accepted the change would require a minimum 4' clearance, and this detail would need to be revised. But he said it would meet the current standard today. Jim Badowich asked if the lines in warped area of the section view were needed. Mr. Herz said the change did not affect the section view.

e. **Case 11-01E – Correct references in Sections 603 and 738. NEW.** Bob Herz said he found incorrect references in Sections 603.1 and 738.1. These sections should reference 615.11 instead of 615.10.
f. **Case 11-01F – Change "plaster" to "mortar" in Section 625 and Details 421, 422, 501-1 and 501-2. NEW.** Peter Kandaris said that when the working group was reviewing the aggregates case, they removed reference to plaster as a specific material. When searching for any references to plaster, they found it in the section and details mentioned, however, it really is a type of mortar. This correction simply changes references of "plaster" to the correct term "mortar."
g. **Case 11-01G – Update references to deleted Detail 190. NEW.** Mr. Kandaris said Mr. Tyus informed him of a few references to Detail 190 in Sections 301 and 601. Since Detail 190 was deleted as part of Case 11-04, references to it also needed to be updated to the ARIZ 227c standard.

Mr. Tobiasson confirmed that all correction cases would be voted on together. Warren White moved and Greg Crossman seconded a motion to approve Case 11-01 A-G as presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

7. Case 11-06 – Deletion of Out of Date MAG Standards

Remove sections and details that are no longer used or refer to outdated technologies. Scott Zipprich passed out a revised version, compiled with assistance from Peter Kandaris, based on feedback from Maricopa County and Mesa. Mr. Zipprich noted that *Detail 302 Joint Restraint with Tie Rods* would not be deleted because it is used occasionally by Mesa. Mr. Herz recommended that Detail 425 not be deleted since it is used by Flagstaff. Mr. Kandaris said once the Outside Right-of-Way manual is ready it could be included there, and then deleted from MAG if desired. Mr. Kandaris also said that since all the sections on pilings were on the list for deletion, references to them in Sections 505 and 506 also needed to be updated. A handout provided during the meeting showed these changes. Mr. Herz commented that where the Engineer was specified in *505.4 Falsework*, it should be changed to the "Contractor's Engineer" to clarify the responsibility. Jim Badowich asked if this addition changed the intent of deleting whole sections. Mr. Kandaris said their initial search didn't find the reference, because it was just to pilings in general, rather than a specific section or detail. He felt that as long as the information was presented and clear as part of the case it should be acceptable. Other members agreed. Mr. Tyus recommended that any other references to sections or details that were deleted due to this case also be deleted. Mr. Herz recommended that if any of these are found, they be brought back to the committee at the next meeting. Greg Crossman moved and Bob Herz seconded a motion to approve Case 11-06 as presented, with the modifications that included keeping Details 302 and 425, updating Sections 505 and 506 as discussed, and reporting any additional references to deleted

sections at the next meeting. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

8. Case 11-09 – Update Preservative Seal for Asphalt Concrete

   Revise Sections 334 and add new 718 to meet current industry materials and practice. Jeff Benedict said he received no new comments, and believed it was ready for a vote. Marc Palichuk moved and Greg Crossman seconded a motion to approve Case 11-09 as presented. A roll call vote was taken. The case was approved: 11 yes, 0 no, 2 abstaining, 2 not present.

9. Case 11-10 – Curb Ramp Modification for Radial Installations

   Add new detail 234 and modify existing ramp details to show curb modification. Details 235-1 through 235-3 in the packet were revised based on comments from the August meeting. Bob Herz asked if there were any comments. Tom Wilhite asked about the 2% cross-slope specification based on Access Board guidelines. Mr. Herz said the details are currently ADA compliant, and that the case was only making the adjustments to straighten the area where the curb and detectable warning meet. He said that when new ADA requirements go into effect, the ramp details would likely need to be revised, but that would be a separate case. Bob Herz moved and Jim Badowich seconded a motion to approve Case 11-10 as presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

10. Case 11-11 – ASTM Revisions

    a. **Case 11-11A – Nuclear Density Testing of Soil.**
    b. **Case 11-11B – Chain Link Fence.**

    Mr. Kandaris said there were no changes or comments, and asked for a vote on the case. He added that he hoped to present more ASTM-related cases next year. Scott Zipprich moved and Bob Herz seconded a motion to approve Case 11-11 as presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

11. Case 11-15: Modify Residential Speed Hump: Detail 210

    Updated speed hump detail to be compliant with MUTCD marking requirements. Bob Herz asked to clarify what was changed in the latest detail. Warren White said only the plan view changed to reflect the current striping standards. All other revisions were not included, as discussed at the previous meeting. Greg Crossman moved and Tom Wilhite seconded a motion to approve Case 11-15 as presented. A roll call vote was taken. The case was approved: 12 yes, 0 no, 1 abstaining, 2 not present. Mr. Kandaris asked agency members to review their supplements to this detail and remove them if possible.

12. Case 11-17: Revise Section 520: Steel and Aluminum Handrails

    Provide material requirements for aluminum handrails in subsection 520.2 and update the welding references. Bob Herz said *Part b* on the cover page of the case (changing the title of

Detail 145) was not necessary because the handrails described in Section 520 are different than the safety rail in Detail 145. Peter Kandaris agreed, stating his intention was only to make changes to Section 520, and not the detail drawing. With this understanding Bob Herz moved and Marc Palichuk seconded a motion to approve Case 11-17 as presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

13. Case 11-20: Update MAG Specifications for Low-lead Brass Water Line Materials

    Update MAG specifications (610, 630, 631, 754, 755) referencing brass and bronze water line construction materials to meet new federal low lead standards. Warren White said he discussed the case with Jami Ericson and Phoenix is okay with the final case as submitted. Warren White moved and Greg Crossman seconded a motion to approve Case 11-20 as presented. A roll call vote was taken. The case was approved: 12 yes, 0 no, 1 abstaining, 2 not present.

14. Case 11-22: Revise Sections 325 and 717: Asphalt Rubber Specifications

    Separate material and construction methods and give guidance to rubber specification. Jeff Benedict said he received a series of comments from John Shu at Maricopa County. These comments, his response, and a revised case were provided as handouts at the meeting. Mr. Benedict explained that industry agreed with most of the comments, and made appropriate changes to Sections 325 and 717 based on them. There were a few areas where he thought additional discussion and review was necessary to clarify the proposed changes. Bob Herz said Maricopa County did not have a chance to review the response to Mr. Shu's comments prior to the meeting and proposed delaying the vote until the October meeting. Mr. Benedict said he would work with the county and asked for additional comments. Chair Tobiasson asked that revisions to cases planned for an October vote be prepared and released as soon as possible so members could review them prior to the meeting.

15. Case 11-24: Add new Section 337: Crack Sealing and Crack Filling

    Add a new section with clear limits of its use and scope of crack sealing. Bob Herz said Maricopa County had comments relating to the viscosity of the sealant. He said the County currently has difficulty with sealant going into cracks, and a higher maximum viscosity would make the problem worse. Mr. Kandaris said he also had some concerns about the viscosity, and may also provide comments. He also mentioned past discussions about not allowing the blowing out of cracks, but rather use vacuuming. Mr. Benedict said he would need to get with industry experts on these issues to address changes and concerns, and asked to postpone the vote until the October meeting.

16. Case 11-25: Update Section 713: Emulsified Asphalt Materials

    Update Section 713: Emulsified Asphalt Materials to include current products and standards. Jeff Benedict said he received no new comments, and believed it was ready for a vote. Warren White moved and Bob Herz seconded a motion to approve Case 11-25 as

presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

17. Case 11-26: Revise Section 332 and 715: Slurry Seal Material and Application

    Revise Section 332 and 715: Slurry Seal Material and Application to include current practice and technologies. Jeff Benedict said there had been no comments or changes. Syd Anderson moved and Warren White seconded a motion to approve Case 11-26 as presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

18. Case 11-27: Update Section 335: Hot Asphalt Rubber Seal

    Update Section 335: Hot Asphalt Rubber Seal (Chip) to include current practice and technologies including blending of rubber binder. Jeff Benedict said there had been no comments or changes. Greg Crossman moved and Scott Zipprich seconded a motion to approve Case 11-27 as presented. A roll call vote was taken. The case was approved: 12 yes, 0 no, 1 abstaining, 2 not present.

19. Case 11-28: Revise Section 716: Cover Material

    Revise Section 716: Cover Material to include a better description of "pre-coat" and method. Update references as needed. Jim Badowich asked if the new specification required pre-coated chips. Mr. Benedict responded, no, it was only an option. Peter Kandaris said the case also incorporates the aggregate requirements. Bob Herz moved and Jason Mahkovitz seconded a motion to approve Case 11-28 as presented. A roll call vote was taken. The case was approved: 13 yes, 0 no, 0 abstaining, 2 not present.

Review of 2011 Cases Scheduled for a Vote in October

20. Case 11-13 – Replace Current Manhole Frame and Cover Details

    Replace Details 423, 424, 523-1 and 523-2 with new details of products that are currently being manufactured. Scott Zipprich said he did not receive final updates to the case yet including noting the texture on the cover surface. Jim Badowich provided a summary of discussion of this item at the Water/Sewer working group meeting. He said that Rita Chihanik, who has been working the details, suggested making a revision to the detail that would make the lip of the frame thinner, which would make the frame lighter and less expensive to cast. Mr. Badowich went on to describe recent problems with rusted frames in the field, which gave him second thoughts about reducing the thickness of the manhole frame, as per its ability to resist corrosion. A sample detail from Neenah foundry was included in the agenda showing the thinner lip dimension. Mr. Badowich said he was assured the detail would meet the loading and testing performance specifications. Scott Zipprich asked if once the frame is incased in concrete does the thickness really matter. He suggested leaving the thickness undimensioned.

There was also discussion about the weight of the frames. The working group discussed whether there should be a minimum weight or a range plus or minus a certain percentage. Mr. Zipprich questioned having a weight requirement, for example ductile iron would not meet such a requirement. Troy Tobiasson said he could understand the cover having a weight requirement so that it would not come off, but was not sure that the frames had to be a certain weight.

Additional discussion centered on the thickness of the frames. Suggestions included making it a minimum thickness, but not specifying an exact dimension so that different foundries can design castings that meet the weight and performance requirements. Members also discussed ways of noting the textured area on the covers regarding bumps and rings, by including some kind of dimension or tolerance. Mr. Zipprich said he would work with Ms. Chihanik to update the details and believes the case can be ready for a vote in October.

21. Case 11-19: Modify Section 340: Detectable Warnings

Modify Section 340 to provide performance-based detectable warning specifications. Peter Kandaris said this case was discussed at the Outside Right-of-Way working group meeting. He thought the general consensus was that agencies wanted material options other than just concrete, but the proposed case included performance specifications based on just concrete material. He suggested removing the performance-based specification section from the current case, and simplifying it to include the ADA-related language. It would include the existing text that allows agencies to specify materials from an approved list. Mr. Kandaris said a new case next year could include an expanded list of materials, each with their appropriate performance standards, similar to what was done in the previous dust palliatives case.

Jim Badowich asked if it included anchorage requirements. Niranjan Vescio said that the section on anchorage could be revised and included. Scott Zipprich asked if it excluded adhesive-type systems. A consensus agreed that adhesives should not be an option. Mr. Kandaris and Mr. Vescio agreed to make revisions to the case to simplify it and address these additional concerns, with plans to vote on the case in October.

22. Case 11-23: Revise Section 321: Asphalt Concrete Pavement

Address compaction issues and update Section 321. Jeff Benedict said that if you review the 'road map' provided by Peter Kandaris and read the final clean version, the changes are pretty clear. A summary of the revisions to Section 321 were included. Jim Badowich asked about limits of air voids in the penalty table 321-8. He wanted to know why there wasn't information for lifts less than 1.5 inches. Brian Gallimore explained that for 1" and 1 ¼" lifts you can't accurately test for air voids. Mr. Badowich said he would like to increase penalties. He gave an example of a recent project in Avondale that didn't meet density requirements, but the penalty was only $6,000 – much less than the cost to make repairs or the value of reduced service life. Tom Wilhite said Tempe also has had problems not meeting density. Brian Gallimore stated the penalties have not changed since 2009. Mr. Wilhite suggested that the committee take a look at the issue of penalties overall, and may want to include

escalation factors or index them to the CPI. Scott Zipprich agreed that the penalty doesn't cover the cost. Peter Kandaris said this may be a good topic for next year. Brian Gallimore said it is unfair to contractors if they are told exactly how to do the job, but if it doesn't meet spec, they have to tear it up. He added that he also questions the accuracy of testing, and that is where conflicts often arise. Mr. Badowich said it cost Avondale $80,000 to make repairs. Adrian Green said for ranges around 8% an engineering analysis can be done, and often it can show the project is acceptable. He also said ADOT has a set penalty of $5 per ton, and they use a referee. On non-ADOT projects sometimes tests are done by labs that may not be as familiar with the test or perform it as frequently.

Troy Tobiasson suggested that this topic be postponed for later, and asked what needed to be done to move the case forward for an October vote. Members agreed that the current case did not deal with penalties. Jeff Hearne said they need comments from the agencies. Adrian Green said they would investigate how the penalties have been working since the last update. Members were asked to provide comments to Jeff Benedict.

23. Case 11-29: Revise Section 701. Rock, Gravel and Sand (renamed Aggregates)

Revise Section 701. Change title from Rock, Gravel and Sand to Aggregates. Move materials to appropriate sections, and clarify types of aggregates. Update all references to Section 701. Brian Gallimore said Peter Kandaris did a lot of work on the case deferred to him. Mr. Kandaris said you can follow the road map he laid out to see what changed and what was moved where. He suggested printing it out in color for review. Blue text gave the reason for the change, red text was the actual change. Jeff Hearne said they received comments from Art Glover from the Flood Control District of Maricopa County. They addressed his questions and made changes as appropriate. Bob Herz asked if this case was conditional on other cases being approved. The sponsors said that the case as now presented includes the necessary changes to other sections and can stand alone. The case is scheduled for a vote in October.

24. Case 11-30: Update Section 702: Base Material and Section 310 Untreated Base Course

Update Section 702: Base Material. Revise for current standards. As with other cases, a roadmap of changes and revisions were presented, which included adding changes to Section 310 as discussed at the previous meeting. Jeff Hearne said he appreciated comments received that helped clarify the tables, and asked for additional comments. He said he would like to vote on the case in October.

25. Case 11-31: Revise Sections 220 and 703: Riprap

Revise Sections 220 and 703: Riprap. Indicate proper aggregate size and testing methods. Jeff Hearne said there were no new changes to the riprap case, but a road map and summary of changes were provided in the agenda packet. Peter Kandaris said in addition to including the aggregates specs, they also tried to remove subjective language like "round" and "angular" and use more precise specifications. The case is scheduled for a vote in October.

26. Case 11-32: Modify Section 309: Lime Slurry Stabilization

Modify Section 309: Lime Slurry Stabilization to include the use of hydrated lime, add mix criteria, testing procedures and payment. Brian Gallimore said he has not received any comments. Scott Zipprich asked if the specifications are based on those used by ADOT and MCDOT. Mr. Gallimore said the case adds the option of hydrated lime, and said the amount needed to be determined by an engineer based on the purpose and application rather than using a specific percentage like 5%. Members agreed that a mix design should be provided. Mr. Gallimore asked for comments and to vote on the case in October.

27. Case 11-33: Revise Section 311: Soil Cement Base Course

Revise Section 311: Soil Cement Base Course. Clarify and update the construction methods of cement treated subgrade. Discussion included adding options for engineering analysis. Mr. Gallimore asked for comments and to vote on the case in October.

28. Case 11-34: Revise Section 312: Cement Treated Base

Revise Section 312: Cement Treated Base to add provisions for measuring moisture content and update density testing procedures. Peter Kandaris said this case and Case 11-33 were fairly straightforward. He asked members to review them and provide any comments before a vote next month.

Carry Forward Cases

29. Case 11-21: Add new Section 623: Special Bedding for Mainline Storm Drain Pipe

Incorporate City of Phoenix supplement 623 into the MAG standards. Earlier in the meeting Syd Anderson said he wanted to vote on this case at the October meeting, however, he was not present when this case was discussed. Bill Davis, representing NUCA said his company ADS will have an engineering statement opposed to the case. Mr. Tobiasson asked him why. Mr. Davis said HDPE pipe uses ASHTO specifications, and the pipe is not designed for the use of a slurry backfill for bedding. He said it also adds to the cost of installation. A member commented that Phoenix has used this even for concrete pipe. Paul Nebeker said he thinks encapsulating pipe in slurry was a kneejerk reaction to an earlier problem that is no longer relevant. Since Syd Anderson was not present to respond, Chair Tobiasson said he expected this case to be carried forward to 2012.

There were no comments on other carry forward cases.

30. Working Group Reports

Chair Tobiasson extended gratitude to the working groups and participants for all the work during the past year, and have given the agencies much to work on.

a. **Specifications and Details Outside the Right-of-Way Working Group**
Peter Kandaris said the meeting followed the Water/Sewer group (August 23) and basically reviewed the current cases, much of which was previously discussed during the meeting. He said the next meeting is planned for September 20 at about 2:45 p.m. at the MAG building. *(Updated meeting notes were provided at the meeting.)*

b. **Asphalt Working Group**
Jeff Benedict said the asphalt group is planning to meet to work on issues raised by Maricopa County. He wants to meet with John Shu about asphalt-rubber and with Craftco for the crack seal issues. He will send out a notice when a meeting date is set.

c. **Materials Working Group**
Brian Gallimore said no meeting is scheduled for this month. He acknowledged all the people that worked on cases coming out of the Materials Working Group including suppliers and testing labs. He said he is waiting for feedback on current cases and will be beginning a list of potential revisions for next year.

d. **Water/Sewer Issues Working Group**
Jim Badowich said the August 23 meeting discussed current cases including the manhole frame and covers previously mentioned. The group is also working on revising manhole details, and is considering requiring steel reinforcement for manhole bases 12' or deeper. They are reviewing the use of precast bases and hope to get some specifications from California. Scott Zipprich said Buckeye is developing a precast option, and is finding most of the resistance is coming from the manufacturers. Mr. Zipprich also said he was continuing to work on the fire hydrant details and was looking for comments from the committee. Jim Badowich reminded members to have them reviewed by their fire departments. Mr. Zipprich said the topic of hydrant threads was also discussed. *(Meeting notes were provided in the agenda packet.)* The next meeting is scheduled for September 20 at 1:30 p.m. in the MAG offices.

e. **Concrete Working Group (5/18/11)**
Jeff Hearne said the group has a meeting scheduled for September 21, but may be canceled if there are no comments to related cases. He will send out a cancelation notice if needed. *(Meeting notes were provided in the agenda packet.)*

31. <u>Staff Reports</u>

Mr. Tyus said the next committee meeting should be held in the Ironwood room, which is quite a bit larger than the current meeting room. It was unavailable today because the chairs were not in yet.

Gordon Tyus also said staff was moving ahead with preparing and proofreading the draft new edition of Specification and Details book including updating sections based on cases that have been previously approved.

32. Open General Discussion

Paul Nebeker said he was having discussions about the cadmium bolts case and it would be carried over to 2012.

Jim Badowich thanked Gordon Tyus for taking good notes. Jeff Benedict added that he appreciated the staff support in preparing materials and supporting the committee and working groups.

Chair Tobiasson asked for suggested improvements for next year. Mr. Benedict suggested getting comments back quickly, and voting on cases earlier to avoid a backlog at the end of the year.

Jami Erickson asked if the committee was interested in continuing meetings year round. This would mean adding meetings in November and December. Gordon Tyus responded by emphasizing the need to have cases approved by October so that the updated books could be approved through the MAG process and printed by January, but also said most committees do meet year-round, and said he thought this committee could as well if so desired. Some member expressed pros of maintaining momentum on work, which would allow cases to be approved earlier in the year. Mr. Tobiasson suggested the topic be on the agenda for further discussion at the next meeting.

33. Adjournment:

Mr. Tobiasson adjourned the meeting at 4:05 p.m.

2011 PROPOSED REVISIONS TO MAG SPECIFICATIONS AND DETAILS

(Updated information can be found on the website: http://www.azmag.gov/Projects/Project.asp?CMSID=1055&CMSID2=1136

CASE	DESCRIPTION	PROPOSED BY	MEMBER	SUBMITTAL DATE Last Revision	VOTE DATE	VOTE	
10-05	Case 10-05: Revise FOREWORD to clarify use of the *MAG Specifications and Details for Public Works Construction* document.	Peoria/ SRP	Peter Kandaris	03/03/2010 08/03/2011	Approved 09/07/2011	13 0 0	Yes No Abstain
10-08	Case 10-08: Re-write Section 717 ASPHALT-RUBBER (Incorporated in Case 11-22.)	MCDOT	Bob Herz	05/05/2010 02/18/2011	Withdrawn 07/13/2011	0 0 0	Yes No Abstain
10-12	Case 10-12: New Section 361 – Shallow Depth Fiber Optic Micro-Conduit Installation.	Scottsdale	Rod Ramos	05/05/2010 02/02/2011	Withdrawn 05/04/2011	0 0 0	Yes No Abstain
11-01	Case 11-01: Miscellaneous Corrections. A. Correct typographical errors in Table 711-1. B. Correct typographical error in Table 705-1. C. Correct errors in Detail 212. D. Correct errors in Detail 262. E. Correct references in Sections 603 and 738. F. Change “plaster” to “mortar” in Section 625 and Details 421, 422, 501-1 and 501-2. G. Update references to deleted Detail 190.	MCDOT/ SRP ARPA	Bob Herz Peter Kandaris Jeff Hearne	01/05/2011 09/07/2011	Approved 09/07/2011	13 0 0	Yes No Abstain
11-02	Case 11-02: Add an Asphalt Pavement Safety Edge option to Detail 201.	MCDOT	Bob Herz	01/05/2011 04/06/2011	Carry forward to 2012	0 0 0	Yes No Abstain
11-03	Case 11-03: Replace cadmium plated bolts referenced in Section 610.13 with zinc plated bolts as described in ASTM-B633.	Peoria	Jesse Gonzales/ Paul Nebeker	02/02/2011 07/13/2011	Carry forward to 2012	0 0 0	Yes No Abstain
11-04	Case 11-04: Replace reference to MAG Detail 190 in MAG Section 301 with ASTM D4718. Delete MAG Detail 190.	OROW WG/ SRP	Peter Kandaris	03/02/2011 05/23/2011	Approved 08/03/2011	10 0 1	Yes No Abstain
11-05	Case 11-05: Move MAG Section 225 Water Requirements into MAG Section 104.1.3.	OROW WG/ SRP	Peter Kandaris	03/02/2011 05/04/2011	Approved 07/13/2011	10 0 0	Yes No Abstain

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CASE	DESCRIPTION	PROPOSED BY	MEMBER	SUBMITTAL DATE Last Revision	VOTE DATE	VOTE	
11-06	Case 11-06: Remove sections and details of the MAG specifications that are no longer used or refer to outdated technologies.	OROW WG/ Buckeye	Scott Zipprich	03/02/2011 09/07/2011	Approved 09/07/2011	13 0 0	Yes No Abstain
11-07	Case 11-07: Revisions to Section 327 - Hot In-Place Recycling.	AGC/ Asphalt WG	Jeff Benedict	05/04/2011 05/13/2011	Approved 08/03/2011	9 0 2	Yes No Abstain
11-08	Case 11-08: Revise Section 711 Paving Asphalt to update performance tables and reference AASHTO standards.	AGC/ Asphalt WG	Jeff Benedict	05/04/2011 07/13/2011	Approved 08/03/2011	10 0 1	Yes No Abstain
11-09	Case 11-09: Preservative Seal for Asphalt Concrete – Revise sections 334 and 718.	AGC/ Asphalt WG	Jeff Benedict	05/04/2011 08/29/2011	Approved 09/07/2011	11 0 2	Yes No Abstain
11-10	Case 11-10: Curb Ramp Modification for Radial Installations – Create new Detail 234. Revise details 235-1, 235-2 and 235-3.	MCDOT	Bob Herz	05/04/2011 08/10/2011	Approved 09/07/2011	13 0 0	Yes No Abstain
11-11	Case 11-11: Superseded ASTM Specifications: A. Nuclear Density Testing of Soil B. Section 772 Chain Link Fence	OROW WG/ SRP	Peter Kandaris	05/04/2011 07/13/2011	Approved 09/07/2011	13 0 0	Yes No Abstain
11-12	Case 11-12: Modifications to Regulatory Requirements, MAG 107.	OROW WG/ SRP	Peter Kandaris	05/04/2011	Carry forward to 2012	0 0 0	Yes No Abstain
11-13	Case 11-13: Replace Manhole Frame and Cover Details 423, 424 and 523 with new updated versions: 423-1, 423-2, 424-1, 424-2, 523-2 and 523-3.	Water/Sewer WG/ Buckeye	Scott Zipprich	06/01/2011 08/30/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-14	Case 11-14: Update Fire Hydrant Detail 360-1, and add Wet Barrel Option (360-2) and Details (360-3).	Water/Sewer WG/ Buckeye	Scott Zipprich	07/13/2011	Carry forward to 2012	0 0 0	Yes No Abstain
11-15	Case 11-15: Modify Residential Speed Hump: Detail 210.	Chandler	Warren White	07/13/2011 08/11/2011	Approved 09/07/2011	12 0 1	Yes No Abstain

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CASE	DESCRIPTION	PROPOSED BY	MEMBER	SUBMITTAL DATE Last Revision	VOTE DATE	VOTE	
11-16	Case 11-16: Modify Section 415: Steel Flexible Metal Guardrail.	OROW WG/ SRP	Peter Kandaris	07/13/2011	Carry forward to 2012	0 0 0	Yes No Abstain
11-17	Case 11-17: Revise Section 520: Steel and Aluminum Handrails.	OROW WG/ SRP	Peter Kandaris	07/13/2011	Approved 09/07/2011	13 0 0	Yes No Abstain
11-18	Case 11-18: Update Section 350: Removal of Existing Improvements.	OROW WG/ SRP	Peter Kandaris	07/13/2011	Carry forward to 2012	0 0 0	Yes No Abstain
11-19	Case 11-19: Modify Section 340: Detectable Warnings.	OROW WG/ SRP	Peter Kandaris w/ N. Vescio	07/13/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-20	Case 11-20: Update MAG specifications for brass and bronze water line construction materials to meet federal low lead standards.	Chandler	Warren White	07/13/2011 08/22/2011	Approved 09/07/2011	12 0 1	Yes No Abstain
11-21	Case 11-21: Add new Section 623: Special Bedding for Mainline Storm Drain Pipe.	Phoenix	Syd Anderson	07/13/2011	Carry forward to 2012	0 0 0	Yes No Abstain
11-22	Case 11-22: Revise Sections 325 and 717: Asphalt Rubber Specifications.	AGC/ Asphalt WG	Jeff Benedict	07/13/2011 09/07/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-23	Case 11-23: Revise Section 321: Asphalt Concrete Pavement	AGC/ Asphalt WG	Jeff Benedict	07/13/2011 08/29/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-24	Case 11-24: Add new Section 337: Crack Sealing and Crack Filling	AGC/ Asphalt WG	Jeff Benedict	07/13/2011 08/24/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-25	Case 11-25: Update Section 713: Emulsified Asphalt Materials to include current products and standards.	AGC/ Asphalt WG	Jeff Benedict	07/13/2011	Approved 09/07/2011	13 0 0	Yes No Abstain

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CASE	DESCRIPTION	PROPOSED BY	MEMBER	SUBMITTAL DATE Last Revision	VOTE DATE	VOTE	
11-26	Case 11-26: Revise Section 332 and 715: Slurry Seal Material and Application to include current practice and technologies.	AGC/ Asphalt WG	Jeff Benedict	07/13/2011	Approved 09/07/2011	13 0 0	Yes No Abstain
11-27	Case 11-27: Update Section 335: Hot Asphalt Rubber Seal (Chip) to include current practice and technologies including blending of rubber binder.	AGC/ Asphalt WG	Jeff Benedict	07/13/2011	Approved 09/07/2011	12 0 1	Yes No Abstain
11-28	Case 11-28: Revise Section 716: Cover Material to include a better description of “pre-coat” and method. Update references as needed.	AGC/ Asphalt WG	Jeff Benedict	07/13/2011	Approved 09/07/2011	11 0 2	Yes No Abstain
11-29	Case 11-29: Revise Section 701. Change title from Rock, Gravel and Sand to Aggregates. Move materials to appropriate sections, and clarify types of aggregates. Update all references to Section 701.	AGC/ Materials WG	Brian Gallimore	07/13/2011 08/22/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-30	Case 11-30: Update Section 702: Base Material. Moved all ABC material to Section 310. Revise Section 310: Untreated Base Course. Revise for current standards. Update all references to Section 702. (Combined with previous Case 11-35.)	AGC/ Materials WG	Brian Gallimore	07/13/2011 08/23/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-31	Case 11-31: Revise Section 703: Riprap. Indicate proper aggregate size and testing methods.	AGC/ Materials WG	Brian Gallimore	07/13/2011 08/23/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-32	Case 11-32: Modify Section 309: Lime Slurry Stabilization to include the use of hydrated lime, add mix criteria, testing procedures and payment.	AGC/ Materials WG	Brian Gallimore	07/13/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-33	Case 11-33: Revise Section 311: Soil Cement Base Course. Clarify and update the construction methods of cement treated subgrade.	AGC/ Materials WG	Brian Gallimore	07/13/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain
11-34	Case 11-34: Revise Section 312: Cement Treated Base to add provisions for measuring moisture content and update density testing procedures.	AGC/ Materials WG	Brian Gallimore	07/13/2011	Scheduled for: 10/05/2011	0 0 0	Yes No Abstain

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Case 11-19 (revised)

DATE: September 20, 2011

TO: MAG Specifications and Details Committee Members

FROM: Niranjan Vescio and Peter Kandaris

RE: **Modification to MAG Section 340: Detectable Warnings**

Purpose: Existing section does not adequately address detectable warning material and placement requirements in accordance with ADAAG standards.

Revisions: Modify Section 340.2.1 as follows:

- Add an introductory paragraph defining the function of detectable warnings, the controlling authority for establishing guidelines and the type of concepts to be specified.
- Provide additional language on installation across adjoining edges.
- Include a minimum static friction coefficient for domes of 0.8 per ADA (28 CFR Part 36 Appendix A, A4.5.1, 4th paragraph for ramps).
- Update color and contrast requirements to include ADA guidelines and delete yellow as the default options (not per the guidelines).
- Include a required design product service life requirement (30 years).
- Add a section on attachment requirements.

Modify Section 340.3.1 as follows:

- Add reference to sidewalk details that show detectable warnings.

Note: Specific material types and their performance criteria have been deleted for this year's case. The Working Group will prepare more comprehensive material requirements for a 2012 case that includes performance criteria for the most common detectable warning products used by member agencies.

340.2.1 Detectable Warnings

Truncated dome dimensions and spacing for detectable warnings are defined by the Americans with Disabilities Act Accessibilities Guidelines (ADAAG) for optimal detect-ability and public safety. The detectable warning design factors, Color and Contrast, Materials, and Attachment System, are defined herein.

Detectable warnings shall consist of raised truncated domes aligned in a square grid pattern in conformity to the ADAAG ~~Americans with Disabilities Accessibility Guidelines~~. Truncated domes shall have the following nominal dimensions: base diameter of 1.0 inches (0.9 inches minimum) top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and height of 0.2 inches. Dome center-to-center spacing of 2.35 inches, measured between the most adjacent domes on the square grid. Dome center-to-center spacing for radial installations shall be 1.6 inches minimum and 2.4 inches maximum with a base-to-base spacing of 0.65 inches minimum. Detectable warning edges shall be sized and installed so that dome spacing is maintained across adjoining edges. Each dome shall have an minimum static friction of coefficient of 0.8 as tested per ASTM C1028.

340.2.1.1 Color and Contrast: Detectable warnings shall contrast visually with adjoining surfaces, either light-on-dark or dark-on-light. Use white where adjacent walking surfaces are dark (e.g. asphalt), and a dark brick red color where adjacent walking surfaces are light (e.g. standard gray concrete). Other colors shall be approved by the jurisdictional agency prior to installation. ~~Visual contrast shall be obtained by color, use safety yellow or other approved color. The color shall be an integral part of the material surface~~ Detectable warnings shall have integral color throughout.

340.2.1.2 Materials: Detectable warning materials shall ~~The material is to~~ be durable with a non-slip surface not subject to spalling, chipping, delamination, or separation. Detectable warnings shall have a design service life of 30 years. All detectable warnings shall be approved by the local jurisdictional agency prior to installation.

340.2.1.3 Attachment System: Detectable warning may be either cast-in-place or recessed. Cast-in-place detectable warnings shall be installed directly into freshly poured concrete (i.e. wet-set) with a proven wet-set anchoring mechanism that assures constant contact of the detectable warning bottom surface with the concrete slurry as it cures, thus rendering the ramp a single monolithic structure. The thicker and heavier detectable warnings lowered into preformed recesses in the concrete substrate must demonstrate a firm fitting into metal reinforced frames without gaps along the edges that can channel water, sand, or debris. They must also be able to resist movement (i.e. sliding, rocking, or lifting) once in service.

340.3.1 Detectable Warnings The detectable warning surface shall be located so that the edge nearest the curb line is 6 inches minimum and 8 inches maximum back from the face of curb. Detectable warning surfaces for railroads shall be located so that the edge nearest the rail crossing is 6 inches minimum and 8 inches maximum from the vehicle dynamic envelope.

Detectable warnings shall be installed perpendicular to the direction of pedestrian/wheelchair travel and have a minimum width of 24 inches measured perpendicular to the edge of the roadway or rail crossing. The base surface of detectable warnings shall be installed flush with the adjacent walkway surface; the truncated domes shall extend above the walkway surface. The boundary between detectable warnings and the adjacent walkway shall provide a flush uniform surface that will not cause ponding of water nor present a tripping hazard. Partial domes at the edge of the detectable warning shall be made flush to match the base surface of the detectable warning. Detectable warnings installed on curb ramps shall extend the full width of the ramp depression.

Detectable warnings installed on sidewalk ramps shall modify the sidewalk concrete thickness at the detectable warning to provide a minimum thickness of four-inches (4”). When detectable warnings are modules inset into the sidewalk ramp, the bottom surface of the sidewalk shall be lowered a distance equal to or greater than the module thickness to maintain the minimum sidewalk thickness. The sidewalk bottom surface shall have a minimum transition taper length of 12” between the thickened and normal depth sections of sidewalk.

Detectable warnings shall be installed as shown in Details 235.1 through 235.5.

Case 11-22

DATE: July 13, 2011

TO: MAG Specification and Details Committee Members

FROM: Jeff Benedict, Asphalt Working Group/AGC

RE: Section 325 and 717

PURPOSE: Separate material and construction methods and give guidance to rubber specification

REVISIONS:
a) Updated required equipment and density procedures
b) Compaction procedures clarified
c) Updated rubber materials along with physical properties

SECTION 325

PLACEMENT AND CONSTRUCTION OF ASPHALT-RUBBER CONCRETE OVERLAY, GAP GRADED

325.1 DESCRIPTION:

Asphalt-rubber concrete consists of supplying, placing and compaction of plant-mixed, gap-graded asphalt-rubber concrete over asphalt surfaces. The thickness of the finished asphalt-rubber concrete overlay shall be within the range of one to two inches as shown on the plans or as specified in the special provisions.

325.2 MATERIALS:

Asphalt-rubber concrete shall consist of a mixture of aggregate, mineral admixture and asphalt-rubber binder as specified in Section 717.

325.2.1 Mixing of Asphalt-Rubber: The temperature of the asphalt-cement shall be between 375°F and 425°F prior to the addition of rubber. No agglomerations of rubber particles in excess of 2" in the least dimension shall be allowed in the mixing chamber. The ground rubber and asphalt cement shall be accurately proportioned in accordance with the asphalt-rubber binder design and thoroughly mixed prior to the beginning of the one hour reaction period. Reaction time may be decreased to 45-minutes if documentation is provided that the physical properties of the mix design requirements are consistently met using a 45-minute reaction period. The Contractor or supplier shall document that the proportions are accurate and that the rubber has been uniformly incorporated into the mixture. Additionally, the Contractor or supplier shall demonstrate that the rubber particles have been thoroughly mixed such that they have been "wetted." The occurrence of rubber floating on the surface or agglomerations of rubber particles shall be evidence of insufficient mixing. The temperature of the asphalt-rubber immediately after mixing shall be between 350°F and 400°F. Reaction time shall start after all of the material for the batch has been mixed and the minimum reaction temperature of 350°F has been achieved.

Prior to use, the viscosity of the asphalt-rubber shall be tested by the use of a rotational viscometer, which is to be furnished by the Contractor or supplier. The Contractor or supplier shall provide a qualified person to perform the testing.

325.2.2Handling of Asphalt-Rubber: Once the asphalt-rubber binder has been mixed, it shall be kept thoroughly agitated during periods of use to prevent settling of the rubber particles. During the production of asphaltic concrete the temperature of the asphalt-rubber binder shall be maintained between 163°C (325°F) and 204°C (400°F). However, in no case shall the asphalt-rubber binder be held for more than 10 hours at these temperatures. It shall be allowed to cool to a temperature of 121°C (250°F) or less and held at that temperature for not more than four days. The process of cooling and reheating shall not be allowed more than one time for a batch of asphalt rubber binder.

For each load or batch of asphalt-rubber binder, the Contractor or supplier shall provide the Engineer with the following documentation:

(A) The source, grade, amount and temperature of the asphalt cement prior to the addition of rubber.

(B) The source and amount of rubber and the rubber content expressed as percent by the weight of total asphalt rubber binder.

(C) Times and dates of the rubber additions and resultant viscosity test.

(D) A record of the temperature, with time and date reference for each load or batch. The record shall begin at the time of the addition of rubber and continue until the load or batch is completely used. Readings and recordings shall be made at every temperature change in excess of 20°F, and as needed to document other events which are significant to batch use and quality.

325.3 WEATHER AND MOISTURE CONDITIONS:

Asphalt-rubber concrete shall be placed only when the surface is dry, and when the atmospheric temperature in the shade is 55°F or above. No asphalt-rubber concrete shall be placed when the weather is foggy or rainy. Asphalt-rubber concrete shall be placed only when the Engineer determines that weather conditions are suitable.

325.4 APPLICATION OF TACK COAT:

A tack coat shall be applied to all existing and to each new course of asphalt concrete prior to the placing of a succeeding lift of asphalt-rubber concrete. The tack coat may be deleted when a succeeding layer of asphalt-rubber concrete is being applied over a freshly laid course that has been subjected to very little traffic when approved by the Engineer.

The application of the tack coat shall comply with Section 329. The grade of emulsified asphalt shall be SS-1h or CSS-1h as specified in Section 713.

The same material that is specified above for the tack coat shall be applied to the vertical surfaces of existing pavements, curbs, and gutters, against which asphalt concrete is to be placed.

The surface to be covered may require repair or patching as directed by the Engineer. This shall be addressed in the project specifications prior to the bidding of the project.

325.5 MIX PRODUCTION:

All materials shall be proportioned by weight in a hot mix asphalt plant in the proportions required by the mix design to provide a homogeneous and workable mass. Each hot mix asphalt plant shall be inspected in accordance with the provisions contained in the 'Hot Mix Asphalt Production Facilities' by the Arizona Rock Products Association and shall have a current inspection certificate. All measuring devices shall be calibrated at least annually by a technician licensed by the Arizona Bureau of Weights & Measures. Mixing plants shall conform to the requirements of AASHTO M156, except as modified herein.

325.6 TRANSPORTATION:

Petroleum distillates or other substances that will have a detrimental effect on the asphalt concrete shall not be used as a release agent.

The beds of all transportation units shall be clean and smooth to allow the free flow of material into the paving machine's hopper.

Tarpaulins shall be furnished on all trucks and used when weather condition warrant, or if directed by the Engineer.

325.7 PLACEMENT:

325.7.1 Surface Preparation:

Before placing asphalt-rubber concrete on existing pavements, severely raveled areas or cracked areas that are depressed more than 3/4" from the adjoining pavement shall be cut out and patched at least 48 hours prior to the resurfacing operation. Over-asphalted (bleeding or flushing) areas or rough high spots shall be removed by burning or blading. Large shrinkage cracks shall be filled with asphalt sealing compound acceptable to the Engineer. The entire surface shall be cleaned with a power broom. Raveled areas that do not require removing shall be cleaned by hand brooming. The above surface cleaning requirements are included as part of the Asphalt-Rubber Concrete paving operations, and the cost thereof shall be included in the Asphalt-Rubber Concrete pay item. Pavement repairs and crack sealing when required are to be compensated for by other appropriate contract pay items.

Prior to placing the asphalt-rubber concrete on milled surfaces, pot-holes left by the milling operation shall be repaired by the Contractor, as a related non-pay item and as required by the Engineer. The milled area shall be swept.

After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat as specified in Section 325.4.

Traffic will not be permitted over surfaces which have received a tack coat. When the overlay is to extend onto a concrete surface, the concrete surface shall be thoroughly cleaned of loose dust and cement particles and shall be tack coated.

325.7.2 Placing and Construction Methods:

All courses of asphalt-rubber concrete shall be placed and finished by means of a self-propelled paving machine equipped with an automatically actuated control system, except under certain conditions or at locations where the Engineer deems the use of a self-propelled paving machine impracticable.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternatively when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with one of the following devices:

(A) Ski or non-contact device of not less than 30 feet in length, supported throughout its entire length
(B) Taut stringline or wire set to grade
(C) Short ski or sonar sensing units from curb control
(D) Joint matching shoe

Failure of the control system to function properly shall be cause for the suspension of asphalt concrete production. In order to achieve a continuous operation, the speed of the paving machine shall be coordinated with the hot mix plant and transport units.

If the asphalt-rubber concrete is dumped from the hauling vehicles directly into the paving machine, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machine by the truck.

If asphalt-rubber concrete is dumped upon the surface being paved and subsequently loaded in the paving machine, the loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphalt concrete shall be picked up and loaded into the paving machine. If asphalt-rubber concrete is placed in a windrow during paving, the windrow shall not exceed a distance greater than 150 feet in front of the paving machine.

Self-propelled paving machines shall spread the mixture without segregation or tearing, true to line, grade and crown indicated on the Project plans. Pavers shall be equipped with hoppers and augers that will distribute the mixture uniformly in front of an adjustable floating screed. The raising of the hopper wings must be minimized and the paving machine will not be operated when in an empty condition.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective, without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required. In the case of the screed, auger extensions and vibrators shall be installed wherever the screed is extended more than one (1) foot beyond the end of the base auger or auger extension. However, when placing material against an extremely uneven curb or edge over a short distance, the Engineer may waive the auger extensions and vibrators.

325.7.3 Compaction: It is the contractor's responsibility to perform any desired Quality Control monitoring and/or testing during compaction operations to achieve the required compaction. The temperature of the asphalt-rubber concrete immediately behind the laydown machine shall be at least 275 °F. A probe type electronic thermometer with a current calibration sticker attached will be used to measure the temperature of the asphalt concrete mixture.

When measuring the temperature of the mat, the probe shall be inserted at mid-depth and as horizontal as possible to the mat. When the pavement lift is less than 1.5-inches, the temperature of the material shall be measured in the truck by inserting a calibrated probe type electronic thermometer, or other approved measuring device, to a point at least 6" below the surface of material.

Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. Pneumatic tired compactors shall not be used.

The Engineer will determine the acceptability of the pavement compaction in accordance with Section 325.10. At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers to provide a uniform and smooth layer over the entire area compacted in this manner.

325.7.4 Lime Water: An application of lime water shall be applied by the Contractor to the compacted asphalt rubber concrete surface after final compaction, prior to opening the roadway to traffic, or when requested by the Engineer to cool the pavement to prevent tracking and pick-up. The lime water solution shall be applied at the rate of approximately ½ gallon/square yard. The lime shall be mixed using a minimum of (1) one 50-pound bag per 3,000 gallons of water.

325.7.5 Adjustments: After installation of an overlay course all necessary frame and cover adjustments for manholes, valve boxes, survey monuments, sewer clean-outs, etc., shall be completed by the Contractor within the given segments being surfaced.

On roads without curb and gutter, the existing shoulder elevation shall be adjusted by the Contractor to match the elevation at the edge of new overlay and slope away from the new pavement surface at a rate that the existing quantity of shoulder material will allow. Shoulder material includes the existing shoulder, millings, untreated base materials, or a granular material approved by the Engineer. Shoulder material shall be compacted to a minimum of 95% of maximum density, determined in accordance with section 301.3.

325.8 QUALITY CONTROL:

It is the contractor's responsibility to perform Quality Control monitoring and/or testing during asphalt-rubber concrete production to achieve the required compaction and to perform Quality Control monitoring and/ or testing during asphalt-rubber concrete production to achieve the required mix properties. The Engineer may obtain samples of any portion of any material at any point of the operations for his own use. Also, the Engineer may order that the use of any drying, proportioning and mixing equipment or the handling of any material be discontinued which, in his/her opinion, fails to produce a satisfactory mixture.

The asphalt-rubber concrete produced shall conform to the requirements of the production tolerances established in section 325.9. When the asphalt-rubber concrete does not conform to the production tolerances, it shall be reported to the Engineer, and corrective quality control measures shall be implemented, or production shall cease immediately at no additional cost to the contracting Agency or Engineer.

325.9 ACCEPTANCE:

325.9.1 Acceptance Criteria: Unless otherwise specified, asphalt-rubber concrete will be divided into 500 ton increments for the purpose of acceptance. Generally, a minimum of one sample will be obtained from each 500 tons of production or fraction thereof for determination of binder content and gradation. Tests used to determine acceptance will be performed by the Engineer or a laboratory employed by the Engineer. In either case the laboratory shall be accredited by the AASHTO Accreditation Program (AAP), for the tests being performed. All acceptance samples shall be taken using random tonnages, locations or times as designated by the Engineer in accordance with ASTM D 3665. Acceptance testing results will be furnished to the contractor within five working days of receipt of samples by the acceptance laboratory.

325.9.2 Gradation, Binder Content and Air Voids:

325.9.2.1 Mineral Aggregate Gradation: For each approximate 500 tons of asphalt-rubber concrete produced, at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of

Arizona Test Method 105 on a random basis. For batch plants, the sample shall be taken from the hot bins. For plants other than batch plants, the sample shall be taken from the cold feed belt. Samples will be taken by means of a sampling device which is capable of obtaining representative samples. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphalt-rubber concrete is less than 500 tons, at least one sample will be taken.

Samples will be tested for conformance with the mix design gradation, with or without mineral admixture as appropriate, in accordance with the requirements of Arizona Test Method 201.

During production, the allowable deviations from the mix design gradation targets are listed in Table 325-1 below. The allowable production tolerances may fall outside of the mix design gradation bands.

TABLE 325-1		
GRADATION ACCEPTANCE LIMITS FOR ASPHALT-RUBBER MIXES		
Sieve Size	1" & 1 ½" Lift Thickness	2" Lift Thickness
1 inch	100%	100%
¾ inch	100%	±6%
½ inch	±6%	±6%
⅜ inch	±6%	±6%
No. 4	±6%	±6%
No. 8	±6%	±6%
No. 30	±4%	±4%
No. 200	±2%	±2%

If the results from a single acceptance sample fall outside of the acceptance limits in Table 325-1 a second sample shall be taken and if the second acceptance sample is also outside of the acceptance limits in Table 325-1 the Contractor shall cease production of asphalt concrete. Production shall not begin again until calibration test results verify that adjustments made to materials or proportions yield a gradation that falls within acceptance limits in Table 325-1.

325.9.2.2 Binder Content: During production of asphalt-rubber concrete, the contractor shall maintain at the plant site a nuclear asphalt content gauge calibrated and operated in accordance with Arizona Test Method 421. At the discretion of the Engineer, the Owner may choose to prepare the calibration samples for use by the contractor. Under the observation of the Engineer, the contractor shall determine the asphalt-rubber binder content by means of the nuclear asphalt content gauge a minimum of four times per full shift. The Engineer shall determine the times that the samples are taken. The contractor's technicians performing the testing, including the calibration of the nuclear gauge, shall meet the technician requirements given in the Arizona Department of Transportation (ADOT) System for the Evaluation of Testing Laboratories. The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, AZ 85009.

Production of asphalt-rubber concrete shall cease immediately and the plant and/or the nuclear asphalt content gauges re-calibrated if any single test result varies by an amount greater than ± 0.60, or the average of three consecutive test results varies by an amount greater than ± 0.40, from the amount determined by the mix design. Material that has already been produced may be used on the project if the single test value representative of that material varies by an amount from ± 0.61 to ± 0.75, inclusive, from the amount determined by the mix design. Material that has already been produced may not be used on the project if the single test value representative of that material varies by an amount greater than ± 0.75 from the amount determined by the mix design unless, by retesting, the material is found to be acceptable.

When there is cause to question the asphalt-rubber binder content being obtained via nuclear asphalt content gauge, or if approved by the Engineer, the asphalt-rubber binder content may be determined using inventory data provided by the supplier as detailed in the following paragraphs. This will only apply for plants providing asphalt-rubber concrete exclusively for the subject project or if an asphalt cement tank is dedicated for the shift of asphalt-rubber concrete production.

The determination of the actual asphalt-rubber binder content by inventory methods may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphalt-rubber concrete production. At any time during asphalt-rubber concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed.

If there is a difference of greater than 0.2 percent asphalt-rubber binder between the asphalt-rubber binder content measured by nuclear asphalt content gauge testing and the actual asphalt-rubber binder content as determined by inventory, the contractor may request that the asphalt-rubber binder content be determined by inventory. The contractor must make such a request in writing within two working days after receiving the test results for the first day of asphalt-rubber concrete production.

325.9.2.3 Marshall Air Voids: For purposes of determining Marshall air voids, the acceptance laboratory will take one sample of the asphalt-rubber concrete in accordance with the requirements of Section 2(h) of Arizona Test Methods 104 or AASHTO T168 for each day's production or as directed by the Engineer's. The minimum weight of the sample shall be 45 pounds. The bulk density shall be tested in accordance with AASHTO T245. The maximum theoretical density shall be tested in accordance with the requirements of AASHTO T209, including fan drying per AASHTO T209 Section 11. Effective voids determined on the laboratory compacted specimens will be determined in accordance with the requirements of AASHTO T269. Should the testing for effective air voids not meet the "Full Payment" or "No Corrective Action" requirements of Table 325-2, additional testing for laboratory air voids on additional samples will be performed as necessary to determine the extent of the deficiency.

TABLE 325-2		
LABORATORY VOIDS ACCEPTANCE AND PENALTIES		
Marshall Air Voids (Measured at 75 blows) Deviation from Mix Design Target	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
± 0% to 1.8%	Full Payment	No corrective action
± 1.9% to 2.9%	$1.00	EA (see 321.10.6)
± 3.0% to 4.0%	$2.50	EA (see 321.10.6)
± Greater than 4.0%	Removal* or EA per 325.10.4	Removal* or EA per 325.10.4

325.9.3 Density: The temperature of asphalt-rubber concrete just prior to compaction shall be at least 275 °F. The Engineer may change the rolling procedure if in the Engineer's judgment the change is necessary to prevent picking up of the asphalt-rubber concrete.

325.9.3.1 Equipment: Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. The compactors shall weigh not less than eight tons. Compactors shall not be used in the vibratory mode for courses of one inch or less in nominal thickness. The wheels of compactors shall be wetted with water, or if necessary soapy water, or a product approved by the Engineer to prevent the asphalt-rubber concrete from sticking to the steel wheels during rolling.

325.9.3.2 Compaction Procedures

325.9.3.2.1 Pavement Lift Thickness 1 ½ Inches or Less: A minimum of three static steel-wheel compactors shall be provided; however, sufficient compactors must be provided so that the drums of the compactors when staggered will cover the entire width of the paving machine on the initial forward pass while a static compactor remains to complete final rolling. The roller(s) for final compaction shall follow as closely behind the initial breakdown as practical, such that a uniformly smooth surface is achieved. As many passes as are possible shall be made with the compactors before the temperature of the asphalt-rubber concrete falls below 220 °F.

325.9.3.2.2 Pavement Lift Thickness Greater than 1 ½ Inches: Achieving the required compaction is the responsibility of the contractor. The number and types of rollers is the contractor's responsibility and shall be sufficient to meet these requirements. Initial breakdown rollers shall follow as closely behind the paving machine as practical. The roller(s) for final compaction shall follow as closely behind the initial breakdown as practical, such that a uniformly smooth surface is achieved..

Compaction will be determined using a correlated thin lift nuclear density gauge and will be monitored for acceptability continuously during construction. The density of the compacted mixture shall not be less than 95% of the laboratory unit weight composed of the same mixture compacted by the 75 blow method of AASHTO T245 at the job mix design specified compaction temperature. The outside one foot of each pass of the pavement course or any unconfined edge will be excluded from testing. The Engineer may exclude areas from the compaction lot that are not accessible by normal compaction equipment.

Nuclear Density Gauge Correlation - During placement of the test strip or on the first day of paving, the pavement surface shall be tested with a thin lift nuclear density gauge at a minimum of four locations. These same locations shall then be cored, using a 4-inch diameter core barrel, and tested for bulk density (AASHTO T166-A, or T275) and a correlation value developed between the nuclear density gauge and the asphalt cores.

325.9.3.3 Compacting Miscellaneous Items and Surfaces: Asphalt-rubber concrete used in the construction of miscellaneous items and surfaces shall be compacted using compactors, hot-hand tampers, smoothing irons, mechanical vibrating hand tampers, or with other devices to the extent considered necessary by the Engineer.

325.9.4 Engineering Analysis (EA): Within 10 working days after receiving notice that a lot or sublot of asphalt-rubber concrete is deficient and is found to fall within the "Removal or EA" band per Table(s) 325-2, the contractor may submit a written proposal (Engineering Analysis) to accept the material in place at the applicable penalties along with possible remediation(s) listed in the "Removal or EA" category. An Engineering Analysis can also be proposed for non-removal categories of "Corrective actions" when the contracting agency is not the owner (i.e. permits).

The Engineering Analysis shall contain an analysis of the anticipated performance of the asphalt-rubber concrete if left in place. The Engineering Analysis shall also detail the effect of any proposed corrective action to the material(s) in place as it relates to the in-place material's performance. The Engineering Analysis shall be performed by a professional engineer experienced in asphalt concrete testing and mix designs. If the lot or sublot is submitted for referee testing by the contractor, the ten working days allowed to prepare an engineering analysis will begin upon notification of referee test results.

When an Engineering Analysis recommends that a specific lot or sublot should not be removed, the Engineering Analysis will recommend that the following penalties (Table 325-3) be paid when the contracting agency is the owner, for the specific criteria being reviewed by the EA.

TABLE 325-3

ENGINEERING ANALYSIS PENALTIES for REMOVAL* LOTS/SUBLOTS LEFT IN-PLACE

Acceptance Criteria	Acceptance Limits	Penalty When Contracting Agency is the Owner ($/Ton)
Laboratory Air Voids (Measured at 75 blows)	Deviation from Target Greater Than ± 4.0%	$3.75

Within 15 working days, the Engineer will determine whether or not to accept the contractor's proposed Engineering Analysis.

325.11 REFEREE:

In the event the contractor elects to question the acceptance test results for laboratory air voids, the Contractor may make a written request for additional testing of the affected material. Any request for referee testing must describe the contractor's reasons for questioning the validity of the original acceptance results and must clearly describe

which set of acceptance tests are in question. The Contractor will engage an independent laboratory who is accredited by AAP in all of the acceptance test methods. The independent laboratory shall be acceptable to the Engineer and shall perform a new set of acceptance tests as required by Section 325.9.2.3 representing the area or set of tests in question. The results of these determinations will be binding on both the contractor and the agency. If the test results obtained by the independent laboratory result in elimination or reduction of the magnitude of the applicable penalty the contracting Agency will bear the cost of the referee testing. If the applicable penalty remains unchanged or increases, the cost for verification testing will be deducted from payments that were to be made to the contractor.

These tests will include Marshall unit weight, maximum theoretical unit weight, and laboratory air voids. Samples for referee testing shall come from representative samples obtained from the completed pavement, as directed by the Engineer.

The number of samples taken will be the same as specified in Section 325.9.2.3. The independent laboratory shall compile the test results and transmit them to both the Engineer and the contractor. The independent laboratory shall include a report signed by an Engineer registered in the State of Arizona, who is experienced in asphalt concrete testing and mix design development. The signed report shall give an opinion that the material evaluated either does or does not comply with project specifications, shall clearly describe any deficiencies, and the results will be binding between all parties.

325.12 MEASUREMENT:

Asphalt-Rubber Concrete shall be measured by the ton, for the mixture actually used, which shall include the required quantities of mineral aggregates, filler material, asphalt-rubber binder and admixture.

Application of Lime Water shall be measured by the square yard. The measured area shall be the area of asphalt-rubber pavement to which the lime water is applied. The measured area shall only be counted one time regardless of the number of applications applied to the asphalt-rubber pavement section.

Shoulder adjustment to match the new pavement surface elevation shall not be measured. The cost of this work shall be included in the price paid for Asphalt-Rubber Concrete or other related pay items.

325.13 PAYMENT:

Payment for Asphalt Milling will be as specified in Section 317.

Payment for tack coat will be by the ton diluted, based on the rate of application, as directed by the Engineer.

Payment for Asphalt-Rubber Concrete will be at the contract unit price, complete in place.

Application of Lime Water as approved by the Engineer will be paid at the contract unit price.

Payment for frame and cover adjustments will be at the contract unit prices specified in the proposal.

SECTION 717

ASPHALT- RUBBER ASPHALT CONCRETE

717.1 DESCRIPTION:

The work under this section shall consist of furnishing, proportioning and mixing all the ingredients necessary to produce an asphalt-rubber material. Asphalt-Rubber Concrete Mixes may be used for low or high traffic conditions, as determined by the agency. Low traffic conditions are conditions where the asphalt mix will be subject to low volume and low weight vehicle usage. Examples of this condition are residential streets, most parking lots and residential minor collector streets. High traffic conditions are conditions where the asphalt mix will be subject to high volume and/or heavy weight vehicle usage as found on major collector, arterial and commercial streets. Street classifications (i.e. minor collector and major collector) shall be determined by the specifying agency.

717.2 MATERIALS:

717.2.1 Asphalt-Rubber Binder:

717.2.1.1 Asphalt Cement: Asphalt cement shall conform to the requirements of Section 711.

717.2.1.2Crumb Rubber: Crumb Rubber shall meet the gradation requirements as shown in Table 717-1 below when tested in accordance with Arizona Test Method 714.

TABLE 717-1	
GRADATION REQUIREMENTS OF CRUMB RUBBER	
Sieve	Percent Passing
Size	Type B
2.36 mm (#8)	
2.00 mm (#10)	100
1.18 mm (#16)	65 - 100
600 µm (#30)	20 - 100
300 µm (#50)	0 - 45
75 µm (#200)	0 - 5

The rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of wire or other contaminating materials, and shall contain not more than 0.5 percent fabric. Calcium carbonate, up to four percent by weight of the granulated rubber, may be added to prevent the particles from sticking together.

Certificates of Compliance conforming to Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction Section 106.05 shall be submitted. In addition, the Certificates shall confirm that the rubber is a crumb rubber, derived from processing at ambient temperature, whole scrap tires or shredded tire materials; and the tires from which the crumb rubber is produced is taken from automobiles, trucks, or other equipment owned and operated in the United States. The Certificates shall also verify that the processing does not produce, as a waste product, casings or other round tire material that can hold water when stored or disposed of above the ground.

717.2.1.3 Asphalt-Rubber Proportions and Properties: Ground rubber in asphalt-rubber binder shall be a minimum of 18 percent by weight of total binder, and processed by ambient grinding.

Asphalt-rubber binder shall be Type 1 unless otherwise specified and conform to the requirements of Table 717-2 below:

TABLE 717-2	
PHYSICAL PROPERTIES OF ASPHALT RUBBER BINDER	
Property	Requirement

	Type I	Type 2	Type 3
Grade of base asphalt cement	**PG 64-16**	**PG 58-22**	**PG 52-28**
Rotational Viscosity*; 350°F, Pascal seconds	1.5-4.0	1.5-4.0	1.5-4.0
Penetration; 4°C (39°F), 200g, 60 sec. (ASTM D 5); dmm, min	10	15	25
Softening Point; (ASTM D 36); °F, min.	135	130	125
Resilience; 77°F (ASTM D 3407); %,min	25	20	15
* The Viscometer used must be a hand held rotational viscometer, such as a Rion (formerly Haake) Model VT – 04, or an equivalent, using Rotor No. 1 . The rotor, while in the off position, shall be completely immersed in the binder at a temperature from 350 to 355 degrees F for a minimum heat equilibrium period of 60 seconds, and an average viscosity determined from three separate constant readings (± 0.5 pascal-seconds) taken within a 30 second time frame with the viscotester level during testing and turned off between readings. Continuous rotation of the rotor may cause thinning of the material immediately in contact with the rotor, resulting in erroneous results.			

717.2.1.4 Asphalt-Rubber Binder Design: At least two weeks prior to the use of asphalt-rubber, the Contractor shall submit an asphalt-rubber binder design prepared by an ADOT approved laboratory. Such design shall meet the requirements specified herein. The design shall show the values obtained from the required tests, along with the following information: percent, grade and source of the asphalt cement used; and percent, gradation and source(s) of rubber used.

717.2.2 Aggregate: Coarse and fine aggregates shall conform to the applicable requirements of Tables 325-3 and 325-4 below. Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Coarse aggregate is material retained above the Number 8 sieve and fine aggregate is material passing the Number 8 sieve. Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent thorough coating with the asphalt cement. Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Table 717-3		
MIX DESIGN GRADATION REQUIREMENTS		
Overlay Thickness	**1” & 1- ½”**	**2”**
Sieve Size	**Percent Passing**	**Percent Passing**
1” (25 mm)	100	100
¾” (19 mm)	100	95-100
½” (12.5 mm)	95-100	78-92
⅜” (9.5 mm)	78-92	61-75
No. 4 (4.75 mm)	28-45	30-40
No. 8 (2.36 mm)	15-25	15-25
No. 30 (600 µm)	5-15	5-15
No. 200 (75 µm)	3.0-7.0	2.0-6.0

The combined aggregate properties shall conform to the requirements of Table 325-2 below.

Table 717-4		
COARSE/FINE AGGREGATE REQUIREMENTS		
Characteristics	**Test Method**	**Requirements**
Fractured Faces, % (Plus No. 8)	ARIZ 212	85, 1 or more
Uncompacted Voids, %	ARIZ 247	45.0 (High Traffic Volume) 42.0 (Low Traffic Volume)
Sand Equivalent (Minus No. 4)	AASHTO T176	65 minimum

Plasticity Index	AASHTO T89 & T90	Non Plastic
L.A. Abrasion, % Loss	AASHTO T96	9 max. @ 100 Rev. 40 max. @ 500 Rev.
Combined Bulk Specific Gravity	AI MS-2	2.35-2.85
Combined Water Absorption, %	AI MS-2	0-2.5

717.2.3 Mineral Admixture: Mineral admixture used in asphalt-rubber concrete shall be dry hydrated lime conforming to the requirements of ASTM C 1097 or Portland cement conforming to ASTM C 150 for Type II, or ASTM C 595 for Type IP. The minimum mineral admixture content will be 1.0percent, by weight of total aggregate.

717.3 MIX DESIGN REQUIREMENT:

717.3.1 General: The mix design for asphalt-rubber concrete shall be prepared by a laboratory that is accredited through the AASHTO Accreditation Program (AAP) in Hot Mix Asphalt Aggregates and Hot Mix Asphalt. The laboratory shall be under the direct supervision of a Civil Engineer, registered by the State of Arizona, and who is listed by ADOT as a "Qualified Asphalt Concrete Mix Design Engineer" within ADOT's latest list of approved laboratories. The latest list of approved laboratories is available on ADOT's web page http://www.azdot.gov/highways/materials/quality_assurance.asp. The date of the design shall not be older than two years from the date of submittal, unless supportive documentation is provided and approved by the Engineer.

The mix design method used shall be in accordance with the Marshall Mix procedure, 75 blows, as described in Arizona Test Method 832 "Marshall Mix Design Method for Asphalt-rubber Concrete (Asphalt Rubber)". Mix designs are subject to approval by the Engineer.

717.3.2 Mix Design Criteria: The mix shall comply with the criteria in Table 325-5 below.

Table 717-5		
MARSHALL MIX DESIGN CRITERIA		
Criteria	Low Volume Traffic	High Volume Traffic
Asphalt Rubber Binder Content 1" and 1-1/2" Overlay Thickness 2" Overlay Thickness	 8.4% minimum N/A	 8.0% minimum 7.0% minimum
Mixture Air Voids, %	3.5-4.5	4.5-5.5
Voids in Mineral Aggregate, %	19.0 min	19.0 min
Tensile Strength Ratio, AASHTO T283	65% minimum	65% minimum
Marshall Stability, pounds minimum	600	600
Marshall Flow, 0.01 inch minimum	16	16

The mix design report shall include the following elements as a minimum.

(1) The name and address of the testing organization and the person responsible for the mix design report.

(2) The mix plant identification and/or location, as well as the supplier or producer name.

(3) The traffic condition (low or high traffic) and lift thickness.

(4) A description of all products that are incorporated in the asphalt-rubber concrete along with the sources of all products, including asphalt binder, crumb rubber, mineral aggregate, and admixtures.

(5) The results of all testing, determinations, etc., such as: specific gravity and gradation, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, Tensile Strength Ratio (AASHTO T 283), Marshall bulk density, stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate. Historical abrasion values may be supplied on existing sources. The submittal should include a plot of the gradation on the Federal Highway Administration's 0.45 Power Gradation Chart and plots of the compaction curves.

(6) The laboratory mixing and compaction temperature ranges for the supplier and grade of asphalt binder used within the mix design.

(7) A specific recommendation for design asphalt-rubber binder content and any limiting conditions that may be associated with the use of the design, such as minimum percentages of crushed or washed fine aggregate.

(8) The supplier's product code, the laboratory Engineer's seal (signed and dated), and the date the design was completed.

(9) The Asphalt-Rubber Binder (ARB) blend design.

The mix design shall be submitted to the Agency or Engineer by the Contractor/Supplier for which it was developed as part of his project submittals. Once the mix design has been approved by the agency or Engineer, the Contractor and/or his supplier shall not change plants nor utilize additional mixing plants without prior approval of the Engineer. Any changes in the plant operation, the producer's pit, the asphalt binder, including modifiers in the asphalt binder, or any other item that will cause an adjustment in the mix, shall be justification for a new mix design to be submitted.

End of Section

Case 11-23

DATE: July 13, 2011

TO: MAG Specification and Details Committee Members

FROM: Jeff Benedict, Asphalt Working Group/AGC

RE: Section 321 - Asphalt Concrete Pavement

PURPOSE: Address compaction

REVISIONS:
a) Updated allowable self-directed target changes
b) Specify asphalt temperature for pavement fabric
c) Installed requirements if asphalt binder and or air voids do not meet target value
d) Changed sample frequency

Gordon Tyus

From: Wilhite, Tom [Thomas_Wilhite@tempe.gov]
Sent: Monday, September 26, 2011 12:10 PM
To: Benedict, Jeffrey
Cc: Gordon Tyus; Troy Tobiasson (troy.tobiasson@goodyearaz.gov)
Subject: Case 11-23 Asphalt Concrete Pavement

Jeff,

Some revision recommendations:

- 321.10.2 1st paragraph, the last two sentences – I recommend to insert the phrase "and the supplier" into the sentence "Acceptance testing results will be furnished to the contractor and the supplier within five working days…". The sentence following this one is requiring that the acceptance laboratory to "ensure" that all reports are provided to the supplier. I see problems with the acceptance laboratory not having the authority or means/ methods to 'ensure' that the reports are made available to the supplier. I recommend that the last sentence be deleted from the case.
- The paragraph following tables 321-3A and 321-3B makes reference to "Table 321-3". Should this be modified to say "Table 321-3A or Table 321-3B"? It occurs three times.
- Title for 321.10.5.1 – The word "thickness" occurs twice in the title. I recommend to eliminate one of the words. It should read as "321.10.5.1 Pavement 1-1/2 Inches or Less in Nominal Thickness:"
- Title for 321.10.5.2 – The word "thickness" occurs twice in the title. I recommend to eliminate one of the words. It should read as "321.10.5.2 Pavement Greater than 1-1/2 Inches in Nominal Thickness:"

Overall a good job.

Thanks,
Tom

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Summary of Revisions to MAG Section 321

a) Table 321-1 – The table previously referenced the #30 sieve. This was originally a target sieve in MAG 710 but was revised in the 2010 edition to the #40 sieve. The values for the allowable target changes were based on ADOT's similar table. ADOT has since revised that table. These changes mirror the ADOT revisions.
b) Section 321.8.4 – The language for determining temperature in the compaction section was clarified.
c) Table 321-2 –The Placement Temperature table was moved to section321.8.4 so that it is located in the same area as the method for determining temperature.
d) Section 321.8.6 – The language regarding traffic on tack coated areas was clarified. Additionally, three typographical errors were corrected; "throughly" was changed to "thoroughly" in two places and "value" was changed to "valve".
e) Section 321.9 – The language regarding production tolerances was clarified.
f) Section 321.10.2 – The statement regarding the mandating of "fan drying" or "drybacks" to determine Maximum Theoretical Specific Gravity was added. The Industry standard is to fan dry the specimen when preparing the mix design. Fan drying the specimen brings it to a "Saturated Surface Dry" (SSD) condition. This value is used to determine laboratory air voids. When aggregate specific gravity and bulk specific gravity of the compacted asphalt specimens is determined, those specimens are also dried to an SSD condition. Therefore, fan drying should also be performed on production samples so that the method for determining mixture air voids on production samples is consistent with the method used in preparing the mix design. This definitely needed clarification since some labs were performing drybacks, some were not, and unless the raw data was presented in the report (which was rare) there was no way to determine if a dryback had been applied.

   Language was added to ensure that the suppliers also receive copies of reports on samples that were obtained and tested since they will ultimately be responsible for the production of the asphalt concrete and any penalties that may result.

   The language for asphalt binder content determination was clarified. Language was also added to determine the limits of the binder deficient area.

   Language for interpreting laboratory air voids and determining deficient areas was added.

g) Table 321-3A and 321-3B – This table was split into two tables; one for Marshall mixes and one for SHRP mixes. Exactly which sieve screens were considered "spec. sieves" was not consistently interpreted. Therefore, the values for the acceptance limits of each specification sieve was more clearly defined. The tables now clearly describe the specification sievesand their allowable deviations for each mix type.

h) Table 321-4 – The title of the table was changed to make it consistent with the title of Table 321-5. Additionally, the footnote regarding Engineering Analysis (EA) was removed from below the table and the reference to EA added in the proper place in the table.
i) Table 321-5 - The footnote regarding Engineering Analysis (EA) was removed and the reference to EA added in the proper place in the table.
j) Section 321.10.4 – The language for evaluating the thickness of the pavement was clarified.
k) Section 321.10.5.1 –A "method-spec" rolling procedure was put into place for lift thicknesses 1½" or less. It is very difficult to obtain cores on these thicknesses of pavement without damaging the cores. **During the SHRP-LTPP study in the late 1980's and early 1990's, protocols were established to omit bulk density testing of drilled asphalt cores 1½" or less. Measurement of pavement thickness, however, was still allowed.**
l) Table 321-7– This table was added to give direction for rolling on pavement lift thicknesses 1½" or less. This table uses the same information that ADOT uses for 416 mixes of the same lift thickness.
m) Section 321.10.5.2 – The number of cores taken for density have been reduced from two to one. When this was put into place, it resulted in up to 16 cores being taken for a lot. If verification or referee cores were taken in deficient areas, the mat would become "swiss cheese". Additionally, language was added as a guide for evaluating density.
n) Table 321-8 – The table number was updated because of the addition of Table 321-6. A typographical error in the heading of the first column was also corrected.
o) Section 321.10.6 – Language was added to clarify the interpretation of "Removal" and "EA" from Table 321-4, 321-5 and 321-9.
p) 321.11 – Clarification language was added as to how and why a referee may occur.

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TABLE 321-1 ALLOWABLE SELF-DIRECTED TARGET CHANGES	
MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (Sieve Size)	
3/8 inch	± ~~3%~~ from mix design target value
No 8	± ~~2%~~ from mix design target value
No ~~20~~ 40	± ~~1%~~ from mix design target value
No 200	~~None~~ ± 0.5% from mix design target value
Binder Content	± 0.2% from mix design target value
Effective Air Voids	None

Table 321-1 changed to match ADOT values and recent ADOT revisions

The contractor may propose target changes, other than self-directed changes, to the approved mix design for the approval of the Engineer. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and gradation limits. The target changes will not be retroactive for the purpose of acceptance.

321.6 MIX PRODUCTION:

All materials shall be proportioned by weight in a hot mix asphalt plant in the proportions required by the mix design to provide a homogeneous and workable mass. Each hot mix asphalt plant shall be inspected in accordance with the provisions contained in the 'Hot Mix Asphalt Production Facilities' by the Arizona Rock Products Association and shall have a current inspection certificate. All measuring devices shall be calibrated at least annually by a technician licensed by the Arizona Bureau of Weights & Measures. Mixing plants shall conform to the requirements of AASHTO M 156, except as modified herein.

In drum mix plants the mineral admixture shall be added and thoroughly mixed with the mineral aggregate by means of a mechanical mixing device prior to the mineral aggregate and mineral admixture entering the dryer. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process.

For drum-mix plants, the mineral admixture shall be weighed across a weigh belt, or other approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer that is in good working condition. The rate of the aggregate feed shall not exceed the mixing device's capacity in ton per hour. The mixer shall be constructed to minimize the loss of mineral admixture and shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected. The mixing device shall be capable of effective mixing in the full range of the asphalt concrete production rates.

The hot plant and equipment shall be constructed and operated to prevent loss of mineral admixture through the dust collection system of the plant.

A positive signal system shall be provided and utilized during production whereby the mixing shall automatically be stopped if the mineral admixture is not introduced into the mineral aggregate. The plant will not be permitted to operate unless the signal system is in good working condition.

The introduction of bituminous material shall be controlled by an automated system fully integrated with the controls or the mineral aggregate and mineral admixture. The production of the plant shall be controlled by the rate required to obtain a uniform mixture of all components. Drying and heating shall be accomplished in such a manner as to preclude the mineral admixture from becoming coated with un-spent fuel. The completed asphalt concrete may be held in storage for up to 12 hours in insulated or heated silos, providing the minimum temperature noted herein for placement and compaction is met behind the placement device. If the Engineer determines that there is an excessive amount of heat, heat loss, drain down, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

The temperature of the asphalt concrete, with unmodified binders, upon discharge from the mixer shall not exceed 335 degrees F. The discharge temperature may be increased on the recommendation of the binder supplier, when approved by the Engineer. If the asphalt concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphalt concrete will be minimized.

the area of the joint shall not deviate more than ¼ inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, parallel to the centerline.

Longitudinal Joints of each course shall be staggered a minimum of 6 inches with relation to the longitudinal joint of the immediate underlying course cold transverse construction joint, the cold existing asphalt concrete shall be trimmed to a vertical face for its full depth and exposing a fresh face. The fresh face shall be tacked prior to placement of the adjacent course. After placement and finishing the new asphalt concrete, both sides of the joint shall be dense and the joint shall be smooth and tight. The surface in the area of the joint shall not deviate more than ¼ inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, parallel to the centerline. The joint will be tack coated if required by the Engineer.

Asphalt

321.8.3 Leveling Course: A leveling course shall be used when specified, or as directed in writing by the Engineer, to bring existing pavement to a uniform grade prior to placing an overlay or other course. If a leveling course is being applied on an Asphalt surface, a tack coat shall be applied. The compaction requirements contained in Section 321.10 do not apply to leveling courses.

Compaction: Asphalt Base Course and Surface Course:

321.8.4 ~~Compaction Base and Surface~~: It is the contractor's responsibility to perform any desired Quality Control monitoring and/or testing during compaction operations to achieve the required compaction. ~~A~~ The temperature of the asphalt concrete immediately behind the laydown machine shall ~~be referenced to~~ meet the minimum requirements of Table 321.~~2~~. ~~The~~ 2. A probe type ~~thermocouple~~ electronic thermometer ~~shall have~~ with a current calibration sticker attached. When measuring the temperature of the mat, the probe shall be inserted at mid-depth and as horizontal as possible to the mat. shall be used to measure the temperature of the asphalt concrete mixture

Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. During the rolling operation, the speed of the roller shall not exceed 3 miles per hour, unless otherwise approved by the Engineer.

Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

The Engineer will determine the acceptability of the pavement compaction in accordance with Section 321.10.

321.8.5 Smoothness: The completed surfacing shall be thoroughly compacted, smooth and true to grade and cross-section and free from ruts, humps, depressions or irregularities. An acceptable surface shall not vary more than one-fourth (¼) inch from the lower edge of a 12-foot straightedge when the straightedge is placed parallel to the centerline of the roadway.

321.8.6 Asphalt Concrete Overlay: Asphalt concrete overlay consists of the placing and compacting plant mix asphalt concrete over existing asphalt concrete paving. The thickness of the overlay shall be as shown on the plans or as specified in the special provisions. Preliminary preparation of existing surfaces will be required except when accomplished by the Contracting Agency, and it is so stipulated in the special provisions. With the exception of those which have been preheated and remixed only, existing surfaces shall receive a tack coat.

Asphalt concrete mix aggregate gradation and percentage of asphalt binder shall be in accordance with Section 710 using a 1/2-inch Marshall-Low Traffic asphalt concrete mix designation for overlay more than one and one-half inch in thickness and a 3/8-inch Marshall-Low Traffic asphalt concrete mix designation for overlay one and one-half inch or less in thickness, unless otherwise shown or specified in the special provisions.

Except when they have been preheated and remixed, pavement surfaces shall be prepared as follows:

(a) Before placing asphalt concrete overlay, severely raveled areas or cracked areas that are depressed more than 3/4-inch from the adjoining pavement shall be cut out and patched at least 48 hours prior to the resurfacing operation. Over-asphalted areas or rough high spots shall be either milled or cut out and patched. Large shrinkage cracks shall be filled with asphalt sealing compound acceptable to the Engineer. The entire surface shall be cleaned with a power broom. Raveled areas that do not require removing shall be cleaned by hand brooming. The above are incidental, and the cost thereof shall be included in the bid items.

(b) Before placing asphalt concrete overlay, milling shall be done as shown on the plans or specified in the special provisions and shall be in accordance with Section 317.

Language changes to clarify meaning. Temperature Table 321-2 moved here (number wrong in text).

TABLE 321.2

MINIMUM ASPHALT CONCRETE PLACEMENT TEMPERATURE

Base (1) Temp (°F)	Mat Thickness (inches)					
	½	¾	1	1 ½	2	3 and greater
40 – 50	---	---	310	300	285	275
50 – 60	---	310	300	295	280	270
60 – 70	310	300	290	285	275	265
70 – 80	300	290	285	280	270	265
80 – 90	290	280	270	270	265	260
+90	280	275	265	265	260	255

(1) Base on which mix is to be placed

be to travel

(c) After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat per Section 321.4. Traffic will not permitted over surfaces which have received a tack coat. When the overlay is to extend onto the concrete gutter, the gutter shall be ~~throughly~~ thoroughly cleaned of loose dust and cement particles and shall be tack coated.

Asphalt concrete overlay shall be placed as specified in Section 321.8.1 and compacted as specified in Section 321.8.4. The surface smoothness shall meet the tolerances specified in Section 321.8.5.

Manholes shall be built up and the frames set flush with the finished surface of the new paving, and tops of value boxes, clean-outs and other existing structures shall be adjusted to finish grade. In the event the base course and original paving have been removed or disturbed in order to build up the manhole, they shall be replaced with approved materials which shall be ~~throughly~~ thoroughly compacted. The asphalt concrete around the manhole frame shall be completed and made flush with the adjacent overlay.

321.8.7 Pavement Fabric Interlayer: Pavement fabric interlayer shall be used only when specified on the plans or in the specifications.

Pavement fabric interlayer shall be in accordance with Table 796-1 and be the class designated on the plans or in the specifications.

Asphalt binder coat used to bond the fabric to the pavement shall be paving asphalt PG 70-10 asphalt cement conforming to the requirements of Section 711. The application and distributing equipment for the asphalt binder shall conform to the requirements of Section 330. The asphalt binder coat shall be uniformly spray applied to the prepared pavement surface at the rate of 0.20 gallons per square yard for Class B fabric or at the rate of 0.25 gallons per square yard for Class A fabric. Some underlying surfaces may require a higher or lower application rate. A test strip may be necessary to determine the proper application rate. The width of liquid asphalt cement application shall be the fabric width, plus six inches.

Neither the asphalt binder coat or fabric interlayer shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. The asphalt binder and fabric interlayer shall only be placed when the pavement is dry, the ambient air temperature is 50 degrees F and rising, and pavement temperature is 40 degrees F and rising.

Equipment for placing the fabric shall be mechanized and capable of handling full rolls of fabric. The equipment shall be able to lay the fabric smoothly to maximize pavement contact and remove air bubbles. Stiff bristle brooms shall be used to smooth the fabric. The equipment used to place the fabric shall be in good working order and is subject to approval by the Engineer.

Pavement fabric interlayer shall not be placed if the in-place binder is hotter than 325 degrees F or has cooled to 180 degrees F or below (as determined by non-contact thermometer).

Pavement fabric interlayer shall be placed onto the asphaltic binder with the heat bonded side up with a minimum amount of wrinkling or folding. Remaining wrinkles or folds 1-inch and larger shall be removed or slit and shingle-lapped in the direction of paving. Burning or torching of wrinkles is not allowed. Fabric shall overlap three to six inches to insure full closure of the joint. Transverse joints shall be shingle-lapped in the direction of paving to prevent edge pickup by the paver. A second application of hand-placed asphalt binder may be required at laps and repairs as determined by the Engineer to ensure proper binding of the narrow double fabric layer.

All areas where fabric has been placed shall be paved with asphaltic concrete during the same workshift. Placement of the asphaltic concrete shall closely follow fabric lay down. The temperature of the asphaltic concrete immediately behind the laydown machine shall not exceed 325 degrees F. In the event that the asphalt binder coat bleeds through the fabric causing construction problems before the overlay is placed, the affected areas shall be sanded with a sand blotter in compliance with Section 333. Excess sand shall be removed before beginning the paving operation. In the event of rainfall prior to the placement of the asphaltic concrete, the fabric shall be allowed to dry before the asphalt concrete is placed.

Language and misspelling changes.

Turning of the paving machine or of other vehicles on the fabric shall be gradual and kept to a minimum to avoid damage to the fabric. Should equipment tires stick to the fabric during pavement operations, small quantities of paving asphalt concrete shall be broadcast on the fabric to prevent pick-up. Decrease of binder rate in order to minimize pick-up on tires is not allowed.

TABLE 321.2

MINIMUM ASPHALT CONCRETE PLACEMENT TEMPERATURE

Base [1] Temp (°F)	Mat Thickness (inches)					
	½	¾	1	1½	2	3 and greater
40 – 50	---	---	310	300	285	275
50 – 60	---	310	300	295	280	270
60 – 70	310	300	290	285	275	265
70 – 80	300	290	285	280	270	265
80 – 90	290	280	270	270	265	260
>90	280	275	265	265	260	255

(1) Base on which mix is to be placed

Moved into Section 321.8.4

321.9 QUALITY CONTROL:

It is the contractor's responsibility to perform Quality Control monitoring and/or testing during asphalt concrete production to achieve the required compaction and to perform Quality Control monitoring and/ or testing during asphalt concrete production to achieve the required mix properties. The Engineer may obtain samples of any portion of any material at any point of the operations for his own use. Also, the Engineer may order the use of any drying, proportioning and mixing equipment or the handling of any material discontinued which, in his/her opinion, fails to produce a satisfactory mixture.

The asphalt concrete produced shall conform to the ~~properties~~ requirements of the ~~mix design~~ production tolerances established in Section 321.10. When the asphalt concrete does not conform to the ~~approved mix design properties~~ production tolerances, it shall be reported to the Engineer, and corrective quality control measures shall be implemented, or production shall cease immediately at no additional cost to the contracting Agency or Engineer.

Reference to mix design is not technically correct. This should be the specified production tolerances in MAG.

321.10 ACCEPTANCE:

321.10.1 Acceptance Criteria: Unless otherwise specified, asphalt concrete will be divided into lots for the purpose of acceptance. A lot shall be considered to be one day's production. When the quantity of asphalt concrete placed in a day exceeds 500 tons but is less than 2000 tons, the lot shall be divided into 500 ton sublots or fraction thereof. Where the quantity of asphalt concrete placed in a day exceeds 2000 tons, the day's production will be divided into four (4) approximately equal sublots. A minimum of one sample will be obtained from each lot. Tests used to determine acceptance will be performed by the Engineer or a laboratory employed by the Engineer. In either case the laboratory shall be accredited by the AASHTO Accreditation Program (AAP), for the tests being performed. The acceptance laboratory will take representative samples of the asphalt concrete from each sublot to allow for gradation, binder content, air voids, pavement thickness and compaction of base and surface course. Each sublot will be accepted based upon the test data from the sample(s) from that sublot. All acceptance samples shall be taken using random locations or times designated by the Engineer in accordance with ASTM D 3665.

321.10.2 Gradation, Binder Content and Air Voids: The acceptance laboratory will take a sample of the asphalt concrete in accordance with the requirements of Section 2 or 4 of Arizona Test Methods 104 or AASHTO T168 from each sublot. The minimum weight of the sample shall be 45 pounds. Asphalt binder content and gradation shall be determined in accordance with AASHTO T308 using the ignition furnace for each sublot. The acceptance laboratory is responsible for obtaining the necessary materials and performing an ignition furnace calibration as outlined in AASHTO T308 for each asphalt concrete mixture utilized on the project. The correction factor used for each test shall be clearly indicated on the report. The bulk density for Marshall Mix designs shall be tested in accordance with AASHTO T245. The bulk density for Gyratory mix designs shall be tested in

including fan drying per AASHTO T 209 Section 11

Mandating of fan drying needed to determine Maximum Theoretical Specific Gravity.

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accordance with AASHTO T312. The maximum theoretical density shall be tested in accordance with the requirements of AASHTO T209. Effective voids determined on the laboratory compacted specimens will be determined at a minimum of once per lot in accordance with the requirements of AASHTO T269. Should the testing for effective air voids not meet the "Full Payment" or "No Corrective Action" requirements of Table 321-5, additional testing for laboratory air voids on the remaining sublots will be performed as necessary to determine the extent of the deficiency. Acceptance testing results will be furnished to the contractor within five working days of receipt of samples by the acceptance laboratory.

Language added to ensure that suppliers also receive sample reports.

The acceptance laboratory shall ensure that the supplier is provided copies of all reports of acceptance testing performed on asphalt concrete samples taken to determine compliance with specifications.

Language modified to clarify the use of Table 321-3

~~The allowable deviations for acceptable production of each measured characteristic from the values established in the JMF for each sublot are as follows.~~

During production, the allowable deviations from the mix design gradation targets are listed in the tables below. The allowable production tolerances may fall outside of the mix design gradation bands as follows.:

Sieve Size	3/8-inch Mix	1/2-inch Mix	3/4-inch Mix	Base Mix
1-inch	--	--	--	± 7%
3/4-inch	--	--	± 7%	± 6%
1/2-inch	--	± 7%	--	--
3/8-inch	± 7%	± 6%	± 6%	± 6%
No. 8	± 6%	± 6%	± 6%	± 6%
No. 40	± 4%	± 4%	± 4%	± 4%
No. 200	± 2%	± 2%	± 2%	± 2%

TABLE 321-3A

GRADATION ACCEPTANCE LIMITS FOR ~~ASPHALT CONCRETE~~ MARSHALL MIXES

Maximum Aggregate Size	100% passing
Nominal Maximum Aggregate Size	±7%
No. 8 Sieve to the Nominal Maximum Aggregate Size	±6%
No. 100 and No. 30 Sieves	±4%
No. 200 Sieve	±2%

Table split in two (Marshall & SHRP mixes). Table detailed to insure uniform interpretation and more clearly define sieve sizes.

TABLE 321-3B

GRADATION ACCEPTANCE LIMITS FOR GYRATORY MIXES

Sieve Size	3/8-inch Mix	1/2-inch Mix	3/4-inch Mix
3/4-inch	--	--	±7%
1/2-inch	--	± 7%	± 6%
3/8-inch	± 7%	± 6%	--
No. 8	± 6%	± 6%	± 6%
No. 40	± 4%	± 4%	± 4%
No. 200	± 2%	± 2%	± 2%

If the results from a single acceptance sample fall outside of the acceptance limits in Table 321-3 a second sample shall be taken and if the second acceptance sample is also outside of the acceptance limits in Table 321-3 the Contractor shall cease production of asphalt concrete. Production shall not begin again until calibration test results verify that adjustments made to materials or proportions yield a gradation that falls within acceptance limits in Table 321-3.

Language for asphalt binder content determination clarified; language added to determine limits of binder deficiency.

~~The asphalt binder content shall be considered acceptable if it is within ± 0.40% of the mix design target value.~~

If the asphalt binder content is within ± 0.40% of the mix design target value, the asphalt concrete will be paid for at the contract unit price. If the asphalt binder content deviates by more than ± 0.40% from the mix design target value, the deficient area will be evaluated within the sublot by coring at maximum intervals of 100 feet from the deficient sample. The asphalt content of the original deficient sample will be averaged with the asphalt binder content of the cores taken for re-evaluation to determine compliance with the acceptance requirements. If the resulting average of the asphalt binder content deviates by more than ± 0.40% from the mix design target value, then Table 321-4 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

TABLE 321-4

ASPHALT BINDER CONTENT ~~CORRECTIVE ACTION FOR DEVIATIONS~~ ACCEPTANCE AND PENALTIES

Deviation from that permitted	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Over 0.0 to 0.1% points	$2.00	EA (see 321.10.6)
Over 0.1 to 0.2% points	$6.00	EA (see 321.10.6)
Over 0.2% points	~~Removal*~~	~~Removal*~~

Language cleanup.

~~Note: Removal* refers to Section 321-10.6~~

Removal or EA per Section 321-10.6

Language for interpreting laboratory air voids and determining deficiency added.

If the laboratory air voids fall within a range of 2.8% to 6.2%, the asphalt concrete will be paid for at the contract unit price. If the laboratory air voids are outside of this range, the deficient area will be evaluated within the sublot by coring at maximum intervals of 100 feet from the deficient sample. The laboratory air voids of the original deficient sample will be averaged with the laboratory air voids obtained from each of the cores taken for re-evaluation to determine compliance with the acceptance requirements. If the resulting average of the laboratory air voids is outside the indicated range, then Table 321-5 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

TABLE 321-5

LABORATORY VOIDS ACCEPTANCE AND PENALTIES

Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Less than 1.5%	~~Removal*~~	~~Removal*~~
1.5-2.0%	$2.50	EA (see 321.10.6)
2.1-2.7%	$1.00	EA (see 321.10.6)
2.8-6.2%	Full Payment	No corrective action
6.3-6.9%	$1.00	EA (see 321.10.6)
7.0-8.0%	$2.50	EA (see 321.10.6)
Greater than 8.0%	~~Removal*~~	~~Removal*~~

Language cleanup.

~~Note: Removal* refers to Section 321-10.6~~

Removal or EA per Section 321-10.6

If an agency or Engineer is purchasing asphalt concrete directly from a commercial material supplier, the agency or Engineer will use Section 321.10 and specifically Tables 321-3, 321-4 and 321-5 from Section 321.10 when determining the acceptance of the asphalt concrete with the material supplier.

321.10.3 Surface Testing: If directed by the Engineer surface drainage test shall be performed. The completed surfacing shall be thoroughly compacted, smooth and true to grade and cross-section and free from ruts, humps, depressions or irregularities. An acceptable surface shall not vary more than 1/4 inch from the lower edge of a 12-foot straightedge when the straightedge is placed parallel to the centerline of the roadway. The straightedge shall be furnished by the contractor and shall be acceptable to the Engineer.

All streets shall be water tested for drainage in the presence of the Engineer or designated representative before final acceptance. Any areas not draining properly shall be corrected to the Engineer's satisfaction at the Contractor's expense. Water for this testing shall be provided and paid for by the Contractor.

When deviations in excess of the above tolerance are found, humps or depressions shall be corrected to meet the specified tolerance, or shall be cut out along neat straight lines and replaced with fresh hot mixture and thoroughly compacted to conform with and bond to the surrounding area. Materials and work necessary to correct such deviations shall be at no additional cost to the Contracting Agency.

321.10.4 Asphalt Pavement Thickness: Asphalt Pavement thickness will be determined from cores secured from each sublot for this purpose. Such cores will be taken and measured by the Asphalt Concrete Coring Method. This method can be found at in Section 321.14. Each core location will be patched by the party responsible for the testing.

If the pavement thickness is deficient from the target thickness by 0.25 inches or less, it will be paid for at the contract unit price. If the pavement thickness deficiency is greater than 0.25 inches and the contracting agency is not the owner (i.e. permits) the following steps will apply:

(1) If the thickness deficiency of the pavement exceeds 0.25 inch, the limits of the deficient area will be ~~isolated~~ evaluated by coring at maximum intervals of 100 feet from the deficient core. The thicknesses of the original deficient core will be averaged with the thicknesses of the cores taken from 100 feet on each side of it to determine compliance with the acceptance requirements.

Pavement thickness language clarified.

If the resulting average thickness deficiency is greater than 0.25 inch, then Table 321-6 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

(2) If the pavement thickness from step one above deviates from the target thickness by more than 0.25 inch but not more than 0.50 inch, corrective action will be required. This corrective action will consist of application of a Type II slurry seal coat in accordance to Section 715. The Contractor may present an engineering analysis outlining other proposed remedial measures for the consideration of the Engineer. The Engineer will review the engineering analysis and decide within 30 working days whether to accept the proposed remedial measures.

(3) If the pavement thickness from step one above deviates from the target thickness by more than 0.50 inch, corrective action will be required. The deficient area will be overlaid with no less than 1 inch thick lift, for the full width of the pavement to meet or exceed the designed thickness, with the appropriate end and edge milling, with a mixture approved by the Engineer. The Contractor may present an engineering analysis outlining other proposed remedial measures for the Engineer's consideration. The Engineer will review the engineering analysis and decide within 10 working days whether to accept the proposed remedial measures. If the Engineer chooses to reject the engineering analysis, the indicated overlay will be constructed by the Contractor at no additional cost to the Owner.

If the pavement thickness deficiency is greater than 0.25 inches and the contracting agency is the owner, Table 321-6 will apply.

TABLE 321-6	
ASPHALT PAVEMENT THICKNESS PAYMENT REDUCTION For Thickness Deficiency of More Than 0.25 inches and less than 0.50 inches	
Specified ~~Mat~~ Pavement Thickness	Reduction in Payment or Corrective Action
Less than 1.5 inches	50%
1.50 inches to 1.99 inches	33%
2.00 inches to 2.49 inches	25%
2.50 inches to 2.99 inches	20%
3.00 inches and over	17%

321.10.5.2 Pavement Thickness Greater than 1-1/2 Inches in Nominal Thickness:
~~**321.10.5 Density:**~~ Achieving the required compaction is the responsibility of the contractor. The number and types of rollers is the contractor's responsibility and shall be sufficient to meet these requirements.

In-place air voids shall be determined in accordance with AASHTO T269 utilizing cores taken from the finished pavement. The maximum theoretical density used in the determination of in-place air voids will be the average value from the acceptance samples determined for the Lot as outlined in 321.10.1.

The Engineer will designate ~~two~~ one random test locations for each sublot and the acceptance laboratory will obtain ~~two cores~~ one core from that ~~each~~ location. ~~The two cores will be averaged for acceptance~~. The outside one foot of each pass of the pavement course or any unconfined edge will be excluded from testing. The Engineer may exclude areas from the compaction lot that are not accessible by normal compaction equipment.

The Contractor will provide the traffic control to facilitate any coring operations necessary for compaction acceptance.

Cores will be taken per the Asphalt Concrete Coring Method. This method can be found in Section 321.14. ~~The acceptance laboratory will furnish test~~ Acceptance testing results will be furnished to the contractor within ~~three~~ five working days of receipt ~~of the cores~~ samples by the acceptance laboratory.

If the pavement density has in-place voids of 8.0% or less, the asphalt concrete will be paid for at the contract unit price. If the pavement density has in-place voids greater than 8.0%, ~~the limits of the~~ deficient area(s) will be ~~isolated~~ evaluated for re-evaluation within the sublot by coring at maximum intervals of 100 feet from the deficient core(s), whether deficient or acceptable. The in-place voids of the original ~~deficient~~ core will be averaged with the in-place voids of the cores taken ~~from 100 feet on each side of it~~ to determine compliance with the acceptance requirements. If the average of the in-place voids is greater than 8.0% then Table 321-~~6~~ 8 shall apply to the sublot.

Language clarified.

A "method-spec" rolling procedure was put into place for lift thicknesses 1½" or less. It is very difficult to obtain thin un-damaged cores. SHRP-LTPP studies in the late 1980's - early 1990's established protocols to omit bulk density testing of drilled asphalt cores 1½" or less. Measurement of pavement thickness, however, was still allowed.

If both cores in a sublot are deficient, 3 to 4 additional cores may be necessary to re-evaluate acceptance.

Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

Number of cores taken for density have been reduced from two to one. Present standard requires up to 16 cores being taken for a lot. With verification cores, the mat becomes over sampled ("swiss cheese"). Additional language added as a guide for evaluating density.

321.10.5 Density:

321.10.5.1 Pavement Thickness 1-1/2 Inches or Less in Nominal Thickness: Compaction shall consist of a "Rolling Method Procedure" using an established sequence of coverage with specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as shown in Table 321-7.

The Contractor shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure. Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F. Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

TABLE 321-7				
ROLLING SEQUENCE FOR LIFT THICKNESS 1½" OR LESS				
Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No.1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2- 4*
Finish	Static Steel	Static Steel	1-3	1-3
* Based on the roller pattern which exhibits the best performance.				

TABLE 321-~~7~~ 8		
PAVEMENT DENSITY PENALTIES		
Limits of In-place Air Voids ~~Less~~ than 1.5 inches for lift thicknesses greater	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
8.1% to 9.0%	$4.00	EA
9.1% to 10.0%	$6.00	EA and Type II Surry Seal
10.1% to 11.0%	Removal*	Removal*
Greater than 11.0%	Removal	Removal

Language cleanup and correction of intent

or EA per Section 321-10.6

Notes: ~~Removal refers to Section 321-10.6~~. The Contractor shall remove and replace the entire sublot that is deficient. Removal for In-place Air Voids greater than 11.0% is not eligible for Section 321.10.6.

and is found to fall within the

or EA" band per Tables 321-4, 321-5 and/or 321-8

a lot

321.10.6 Engineering Analysis (EA): Within 10 working days after receiving notice that a sublot of asphalt concrete is deficient ~~for~~ "Removal" ~~by the Engineer~~, the contractor may submit a written proposal (Engineering Analysis) to accept the material in place at the applicable penalties listed in the "Removal" category. Engineering Analysis can also be proposed for non-removal categories of "Corrective actions" when the contracting agency is not the owner (i.e. permits).

along with possible remediation(s)

or EA

Language was added to clarify the interpretation of "Removal" and "EA"

The Engineering Analysis shall contain an analysis of the anticipated performance of the asphalt concrete if left in place. The Engineering Analysis shall also detail the effect of any proposed corrective action ~~on the~~ performance. The Engineering Analysis shall be performed by a professional engineer experienced in asphalt concrete testing and mix designs. If the sublot is submitted for referee testing by the contractor, the ten working days allowed to prepare an engineering analysis will begin upon notification of referee test results.

to the material(s) in place as it relates to the in-place material's

lot or

should

When an Engineering Analysis recommends that a specific lot or sublot not be removed, the Engineering Analysis will recommend that the following penalties (Table 321-~~8~~ 9) be paid when the contracting agency is the owner, for the specific criteria being reviewed by the EA.

Language correction.

TABLE 321-~~8~~ 9		
ENGINEERING ANALYSIS PENALTIES for REMOVAL* LOTS/SUBLOTS LEFT IN-PLACE		
Acceptance Criteria	**Acceptance Limits**	**Penalty When Contracting Agency is the Owner ($/Ton)**
Asphalt Binder Content	Over 0.2% points from that Permitted	$9.00
Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	Less than 1.5% or Greater Than 8.0%	$3.75
Limits of In-place Air Voids	10.1% to 11.0%	$9.00

Within 15 working days, the Engineer will determine whether or not to accept the contractor's proposed Engineering Analysis.

321.11 REFEREE:

either asphalt binder content, laboratory air voids, density or a combination thereof for

Clarification language was added to how and why a referee may occur.

In the event the contractor elects to question the acceptance test results for a sublot, the Contractor may make a written request for additional testing of that sublot. The Contractor will engage an independent laboratory (at the Contractors own expense) who

Any request for referee testing must describe the contractor's reasons for questioning the validity of the original acceptance results and must clearly describe which set of acceptance tests are in question.

Clarification language was added to how and why a referee may occur.

is ~~is~~ accredited by AAP in all of the acceptance test~~s~~. The independent laboratory shall be acceptable to the Engineer and shall perform a ~~complete~~ new set of acceptance tests ~~(~~as required by Section 321.10 representing the area or set of tests in question~~)~~.

The results of these determinations will be binding on both the contractor and the agency.

will These tests ~~shall~~ include asphalt binder content, aggregate gradation, Marshall or Gyratory unit weight, ~~and~~ maximum theoretical unit weight ~~-~~ Samples for referee testing shall come from representative samples obtained from the completed pavement, as directed by the Engineer.

any or all of the following, as directed by the Engineer:

laboratory air voids and in-place air voids (compaction)

The number of samples taken will be the same as specified in Section 321.10. The independent laboratory shall compile the test results and transmit them to both the Engineer and the Contractor. The independent laboratory shall include a ~~letter~~ report signed by an Engineer registered in the State of Arizona, who is experienced in asphalt concrete testing and mix design~~s~~. The signed ~~letter~~ report shall give an opinion that the material evaluated either does or does not comply with project specifications, and shall clearly describe any deficiencies~~, and the~~ . The results will be binding between all parties.

development

321.12 MEASUREMENT:

Asphalt concrete pavement will be measured by the ton, or by the square yard, for the mixture actually used as allowed above, which shall include the required quantities of mineral aggregates, asphalt binder, and mineral admixture. Measurement shall include any tonnage used to construct intersections, roadways, streets, or other miscellaneous surfaces indicated on the plans or as directed by the Engineer.

321.13 PAYMENT:

The asphalt concrete measured as provided above will be paid for at the contract price per ton or square yard, as adjusted per Section 321.10, which price shall be full compensation for the item complete, as herein described and specified.

Payment for tack coat will be by the ton diluted, based on the rate of application, as directed by the Engineer.

No payment will be made for any overrun in quantity of asphalt concrete in excess of 10 percent based on actual field measurement of area covered, design thickness, and the mix design unit weight. The calculations and payment for overrun will be by individual pay item. To compensate or adjust for a thickness deficiency in an underlying asphalt concrete course, the Engineer may authorize a quantity increase in excess of 10 percent for a subsequent asphalt concrete course. In such cases, the quantity in excess of 10 percent will be paid for at the lowest unit price.

Except as otherwise specified in the special provisions, no separate payment will be made for work necessary to construct miscellaneous items or surfaces of asphalt concrete.

321.14 ASPHALT CORE METHOD: Core Drilling of Hot Mix Asphalt (HMA) for Specimens of 4" or 6" diameter

321.14.1 Scope: This method is to establish a consistent method of the use of a diamond bit core to recover specimens of 4 or 6 inch diameter for laboratory analysis and testing. The method will require the use of: water, ice (bagged or other suitable type), dry ice, and a water-soap solution to be utilized when coring asphalt rubber concrete. Individuals doing the specimen recovery should be observing all safety regulations from the equipment manufacturer as well as the required job site safety requirements for actions, and required personal protective equipment.

321.14.2 Core Drilling Device: The core drilling device will be powered by an electrical motor, or by an acceptable gasoline engine. Either device used shall be capable of applying enough effective rotational velocity to secure a drilled specimen. The specimen shall be cored perpendicularly to the surface of pavement, and that the sides of the core are cut in a manner to minimize sample distortion or damage. The machinery utilized for the procedure shall be on a mounted base, have a geared column and carriage that will permit the application of variable pressure to the core head and carriage throughout the entire drilling operation. The carriage and column apparatus shall be securely attached to the base of the apparatus; and the base will be secured with a mechanical fastener or held in place by the body weight of the operator. The core drilling apparatus shall be equipped with a water spindle to allow water to be introduced inside of the drill stem while operating. The cutting edge of the core drill bit shall be of

SECTION 321

ASPHALT CONCRETE PAVEMENT

321.1 DESCRIPTION:

This section is to provide specifications for furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture and asphalt binder to form a pavement course for placement upon a previously prepared base or sub base.

321.2 MATERIALS AND MANUFACTURE:

The materials shall conform to Section 710 for the type specified. The specific required mix type shall be called out in the contract documents or as directed by the Engineer.

321.3 WEATHER AND MOISTURE CONDITIONS:

Asphalt concrete shall be placed only when the surface is dry, and when the atmospheric temperature in the shade is 40 degrees F. (50 degrees F for Asphalt Concrete lift less than 2 inch thick) or above. No asphalt concrete shall be placed when the weather is foggy or rainy, or when the base or sub base on which the material is to be placed is unstable. Asphalt concrete shall be placed only when the Engineer determines that weather conditions are suitable.

321.4 APPLICATION OF TACK COAT:

A tack coat shall be applied to all existing and to each new course of asphalt concrete prior to the placing of a succeeding lift of asphalt concrete. The tack coat may be deleted when a succeeding layer of asphalt concrete is being applied over a freshly laid course that has been subjected to very little traffic when approved by the Engineer.

The application of the tack coat shall comply with Section 329. The grade of emulsified asphalt shall be SS-1 h or CSS-1 h as specified in Section 713.

The same material that is specified above for the tack coat shall be applied to the vertical surfaces of existing pavements, curbs, and gutters, against which asphalt concrete is to be placed.

The surface to be covered may require repair or patching as directed by the Engineer. This shall be addressed in the project specifications prior to the bidding of the project.

321.5 MIX DESIGN

The mix design shall be submitted to the Engineer at least five working days prior to the start of asphalt concrete production. Mix designs provided by the agency may be utilized on projects at the Engineer's discretion. The Engineer will review and approve the mix design to assure it contains all of the required information as outlined in Section 710.3.1. The target values for gradations, binder contents, and air voids will be established as the accepted Job Mix Formula (JMF) based upon the mix design. Mix designs not containing all of the information will be returned within five working days of receipt of all mix design information, for action and resubmission by the Contractor.

Once the mix design has been approved by the agency and the mixing plant selected, the Contractor and/or his supplier shall not change plants nor utilize additional mixing plants without prior approval of the Engineer.

If the contractor elects to change its source of material, the contractor shall furnish the Engineer with a new mix design, which meets the requirements of Section 710, as amended by the Project Specifications.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to the start of production of a lot and will remain in effect until such time as any additional changes are implemented.

The self-directed target changes must meet the contract requirements for mix design criteria and gradation limits.

TABLE 321-1 ALLOWABLE SELF-DIRECTED TARGET CHANGES	
MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (Sieve Size)	
3/8 inch	± 4% from mix design target value
No 8	± 4% from mix design target value
No 40	± 2% from mix design target value
No 200	±0.5% from mix design target value
Binder Content	± 0.2% from mix design target value
Effective Air Voids	None

The contractor may propose target changes, other than self-directed changes, to the approved mix design for the approval of the Engineer. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and gradation limits. The target changes will not be retroactive for the purpose of acceptance.

321.6 MIX PRODUCTION:

All materials shall be proportioned by weight in a hot mix asphalt plant in the proportions required by the mix design to provide a homogeneous and workable mass. Each hot mix asphalt plant shall be inspected in accordance with the provisions contained in the 'Hot Mix Asphalt Production Facilities' by the Arizona Rock Products Association and shall have a current inspection certificate. All measuring devices shall be calibrated at least annually by a technician licensed by the Arizona Bureau of Weights & Measures. Mixing plants shall conform to the requirements of AASHTO M 156, except as modified herein.

In drum mix plants the mineral admixture shall be added and thoroughly mixed with the mineral aggregate by means of a mechanical mixing device prior to the mineral aggregate and mineral admixture entering the dryer. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process.

For drum-mix plants, the mineral admixture shall be weighed across a weigh belt, or other approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer that is in good working condition. The rate of the aggregate feed shall not exceed the mixing device's capacity in ton per hour. The mixer shall be constructed to minimize the loss of mineral admixture and shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected. The mixing device shall be capable of effective mixing in the full range of the asphalt concrete production rates.

The hot plant and equipment shall be constructed and operated to prevent loss of mineral admixture through the dust collection system of the plant.

A positive signal system shall be provided and utilized during production whereby the mixing shall automatically be stopped if the mineral admixture is not introduced into the mineral aggregate. The plant will not be permitted to operate unless the signal system is in good working condition.

The introduction of bituminous material shall be controlled by an automated system fully integrated with the controls or the mineral aggregate and mineral admixture. The production of the plant shall be controlled by the rate required to obtain a uniform mixture of all components. Drying and heating shall be accomplished in such a manner as to preclude the mineral admixture from becoming coated with un-spent fuel. The completed asphalt concrete may be held in storage for up to 12 hours in insulated or heated silos, providing the minimum temperature noted herein for placement and compaction is met behind the placement device. If the Engineer determines that there is an excessive amount of heat, heat loss, drain down, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

The temperature of the asphalt concrete, with unmodified binders, upon discharge from the mixer shall not exceed 335 degrees F. The discharge temperature may be increased on the recommendation of the binder supplier, when approved by the Engineer. If the asphalt concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphalt concrete will be minimized.

321.7 TRANSPORTATION:

Petroleum distillates or other substances that will have a detrimental effect on the asphalt concrete shall not be used as a release agent.

The beds of all transportation units shall be clean and smooth to allow the free flow of material into the paving machine's hopper.

Tarpaulins shall be furnished on all trucks and used when weather condition warrant, or if directed by the Engineer.

321.8 PLACEMENT:

321.8.1 Placing: All courses of asphalt concrete shall be placed and finished by means of a self-propelled paving machine equipped with an automatically actuated control system, except under certain conditions or at locations where the Engineer deems the use of a self-propelled paving machine impracticable.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternatively when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with one of the following devices:

(A) Ski or non-contact device of not less than 30 feet in length, supported throughout its entire length
(B) Taut stringline or wire set to grade
(C) Short ski or sonar sensing units from curb control
(D) Joint matching shoe

Failure of the control system to function properly shall be cause for the suspension of asphalt concrete production. In order to achieve a continuous operation, the speed of the paving machine shall be coordinated with the hot mix plant and transport units.

If the asphalt concrete is dumped from the hauling vehicles directly into the paving machine, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machine by the truck.

If asphalt concrete is dumped upon the surface being paved and subsequently loaded in the paving machine, the loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphalt concrete shall be picked up and loaded into the paving machine.

Self-propelled paving machines shall spread the mixture without segregation or tearing, true to line, grade and crown indicated on the Project plans. Pavers shall be equipped with hoppers and augers that will distribute the mixture uniformly in front of an adjustable floating screed. The raising of the hopper wings must be minimized and the paving machine will not be operated when in an empty condition.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective, without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required. In the case of the screed, auger extensions and vibrators shall be installed wherever the screed is extended more than one (1) foot beyond the end of the base auger or auger extension. However, when placing material against an extremely uneven curb or edge over a short distance, the Engineer may waive the auger extensions and vibrators.

At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers to provide a uniform and smooth layer over the entire area compacted in this manner.

321.8.2 Joints: Transverse joints, before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphalt concrete shall be trimmed to a vertical face for its full depth and exposing a fresh face. After placement and finishing the new asphalt concrete, both sides of the joint shall be dense and the joint shall

be smooth and tight. The surface in the area of the joint shall not deviate more than ¼ inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, parallel to the centerline.

Longitudinal Joints of each course shall be staggered a minimum of 6 inches with relation to the longitudinal joint of the immediate underlying course cold transverse construction joint, the cold existing asphalt concrete shall be trimmed to a vertical face for its full depth and exposing a fresh face. The fresh face shall be tacked prior to placement of the adjacent course. After placement and finishing the new asphalt concrete, both sides of the joint shall be dense and the joint shall be smooth and tight. The surface in the area of the joint shall not deviate more than ¼ inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, parallel to the centerline. The joint will be tack coated if required by the Engineer.

321.8.3 Asphalt Leveling Course: A leveling course shall be used when specified, or as directed in writing by the Engineer, to bring existing pavement to a uniform grade prior to placing an overlay or other course. If a leveling course is being applied on an Asphalt surface, a tack coat shall be applied. The compaction requirements contained in Section 321.10 do not apply to leveling courses.

321.8.4 Compaction; Asphalt Base Course and Surface Course: It is the contractor's responsibility to perform any desired Quality Control monitoring and/or testing during compaction operations to achieve the required compaction. The temperature of the asphalt concrete immediately behind the laydown machine shall meet the minimum requirements of Table 321-2. A probe type electronic thermometer with a current calibration sticker attached will be used to measure the temperature of the asphalt concrete mixture. When measuring the temperature of the mat, the probe shall be inserted at mid-depth and as horizontal as possible to the mat.

TABLE 321-2						
MINIMUM ASPHALT CONCRETE PLACEMENT TEMPERATURE						
Base (1) Temp (°F)	Mat Thickness (inches)					
	½	¾	1	1 ½	2	3 and greater
40 – 50	---	---	310	300	285	275
50 – 60	---	310	300	295	280	270
60 – 70	310	300	290	285	275	265
70 – 80	300	290	285	280	270	265
80 – 90	290	280	270	270	265	260
+90	280	275	265	265	260	255

(1) Base on which mix is to be placed

Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. During the rolling operation, the speed of the roller shall not exceed 3 miles per hour, unless otherwise approved by the Engineer.

Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

The Engineer will determine the acceptability of the pavement compaction in accordance with Section 321.10.

321.8.5 Smoothness: The completed surfacing shall be thoroughly compacted, smooth and true to grade and cross-section and free from ruts, humps, depressions or irregularities. An acceptable surface shall not vary more than one-fourth (¼) inch from the lower edge of a 12-foot straightedge when the straightedge is placed parallel to the centerline of the roadway.

321.8.6 Asphalt Concrete Overlay: Asphalt concrete overlay consists of the placing and compacting plant mix asphalt concrete over existing asphalt concrete paving. The thickness of the overlay shall be as shown on the plans or as specified in the special provisions. Preliminary preparation of existing surfaces will be required except when accomplished by the Contracting Agency, and it is so stipulated in the special provisions. With the exception of those which have been preheated and remixed only, existing surfaces shall receive a tack coat.

Asphalt concrete mix aggregate gradation and percentage of asphalt binder shall be in accordance with Section 710 using a 1/2-inch Marshall-Low Traffic asphalt concrete mix designation for overlay more than one and one-half inch in thickness and a 3/8-inch Marshall-Low Traffic asphalt concrete mix designation for overlay one and one-half inch or less in thickness, unless otherwise shown or specified in the special provisions.

Except when they have been preheated and remixed, pavement surfaces shall be prepared as follows:

(a) Before placing asphalt concrete overlay, severely raveled areas or cracked areas that are depressed more than 3/4-inch from the adjoining pavement shall be cut out and patched at least 48 hours prior to the resurfacing operation. Over-asphalted areas or rough high spots shall be either milled or cut out and patched. Large shrinkage cracks shall be filled with asphalt sealing compound acceptable to the Engineer. The entire surface shall be cleaned with a power broom. Raveled areas that do not require removing shall be cleaned by hand brooming. The above are incidental, and the cost thereof shall be included in the bid items.

(b) Before placing asphalt concrete overlay, milling shall be done as shown on the plans or specified in the special provisions and shall be in accordance with Section 317.

(c) After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat per Section 321.4. Traffic will not be permitted to travel over surfaces which have received a tack coat. When the overlay is to extend onto the concrete gutter, the gutter shall be thoroughly cleaned of loose dust and cement particles and shall be tack coated.

Asphalt concrete overlay shall be placed as specified in Section 321.8.1 and compacted as specified in Section 321.8.4. The surface smoothness shall meet the tolerances specified in Section 321.8.5.

Manholes shall be built up and the frames set flush with the finished surface of the new paving, and tops of value boxes, clean-outs and other existing structures shall be adjusted to finish grade. In the event the base course and original paving have been removed or disturbed in order to build up the manhole, they shall be replaced with approved materials which shall be thoroughly compacted. The asphalt concrete around the manhole frame shall be completed and made flush with the adjacent overlay.

321.8.7 Pavement Fabric Interlayer: Pavement fabric interlayer shall be used only when specified on the plans or in the specifications.

Pavement fabric interlayer shall be in accordance with Table 796-1 and be the class designated on the plans or in the specifications.

Asphalt binder coat used to bond the fabric to the pavement shall be paving asphalt PG 70-10 asphalt cement conforming to the requirements of Section 711. The application and distributing equipment for the asphalt binder shall conform to the requirements of Section 330. The asphalt binder coat shall be uniformly spray applied to the prepared pavement surface at the rate of 0.20 gallons per square yard for Class B fabric or at the rate of 0.25 gallons per square yard for Class A fabric. Some underlying surfaces may require a higher or lower application rate. A test strip may be necessary to determine the proper application rate. The width of liquid asphalt cement application shall be the fabric width, plus six inches.

Neither the asphalt binder coat or fabric interlayer shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. The asphalt binder and fabric interlayer shall only be placed when the pavement is dry, the ambient air temperature is 50 degrees F and rising, and pavement temperature is 40 degrees F and rising.

Equipment for placing the fabric shall be mechanized and capable of handling full rolls of fabric. The equipment shall be able to lay the fabric smoothly to maximize pavement contact and remove air bubbles. Stiff bristle brooms shall be used to smooth the fabric. The equipment used to place the fabric shall be in good working order and is subject to approval by the Engineer.

Pavement fabric interlayer shall not be placed if the in-place binder is hotter than 325 degrees F or has cooled to 180 degrees F or below (as determined by non-contact thermometer).

Pavement fabric interlayer shall be placed onto the asphaltic binder with the heat bonded side up with a minimum amount of wrinkling or folding. Remaining wrinkles or folds 1-inch and larger shall be removed or slit and shingle-lapped in the direction of paving. Burning or torching of wrinkles is not allowed. Fabric shall overlap three to six inches to insure full closure of the joint. Transverse joints shall be shingle-lapped in the direction of paving to prevent edge pickup by the paver. A second application of hand-placed asphalt binder may be required at laps and repairs as determined by the Engineer to ensure proper binding of the narrow double fabric layer.

All areas where fabric has been placed shall be paved with asphaltic concrete during the same workshift. Placement of the asphaltic concrete shall closely follow fabric lay down. The temperature of the asphaltic concrete immediately behind the laydown machine shall not exceed 325 degrees F. In the event that the asphalt binder coat bleeds through the fabric causing construction problems before the overlay is placed, the affected areas shall be sanded with a sand blotter in compliance with Section 333. Excess sand shall be removed before beginning the paving operation. In the event of rainfall prior to the placement of the asphaltic concrete, the fabric shall be allowed to dry before the asphalt concrete is placed.

Turning of the paving machine or of other vehicles on the fabric shall be gradual and kept to a minimum to avoid damage to the fabric. Should equipment tires stick to the fabric during pavement operations, small quantities of paving asphalt concrete shall be broadcast on the fabric to prevent pick-up. Decrease of binder rate in order to minimize pick-up on tires is not allowed.

321.9 QUALITY CONTROL:

It is the contractor's responsibility to perform Quality Control monitoring and/or testing during asphalt concrete production to achieve the required compaction and to perform Quality Control monitoring and/ or testing during asphalt concrete production to achieve the required mix properties. The Engineer may obtain samples of any portion of any material at any point of the operations for his own use. Also, the Engineer may order the use of any drying, proportioning and mixing equipment or the handling of any material discontinued which, in his/her opinion, fails to produce a satisfactory mixture.

The asphalt concrete produced shall conform to the requirements of the production tolerances established in section 321.10. When the asphalt concrete does not conform to the production tolerances, it shall be reported to the Engineer, and corrective quality control measures shall be implemented, or production shall cease immediately at no additional cost to the contracting Agency or Engineer.

321.10 ACCEPTANCE:

321.10.1 Acceptance Criteria: Unless otherwise specified, asphalt concrete will be divided into lots for the purpose of acceptance. A lot shall be considered to be one day's production. When the quantity of asphalt concrete placed in a day exceeds 500 tons but is less than 2000 tons, the lot shall be divided into 500 ton sublots or fraction thereof. Where the quantity of asphalt concrete placed in a day exceeds 2000 tons, the day's production will be divided into four (4) approximately equal sublots. A minimum of one sample will be obtained from each lot. Tests used to determine acceptance will be performed by the Engineer or a laboratory employed by the Engineer. In either case the laboratory shall be accredited by the AASHTO Accreditation Program (AAP), for the tests being performed. The acceptance laboratory will take representative samples of the asphalt concrete from each sublot to allow for gradation, binder content, air voids, pavement thickness and compaction of base and surface course. Each sublot will be accepted based upon the test data from the sample(s) from that sublot. All acceptance samples shall be taken using random locations or times designated by the Engineer in accordance with ASTM D 3665.

321.10.2 Gradation, Binder Content and Air Voids: The acceptance laboratory will take a sample of the asphalt concrete in accordance with the requirements of Section 2 or 4 of Arizona Test Methods 104 or AASHTO T168 from each sublot. The minimum weight of the sample shall be 45 pounds. Asphalt binder content and gradation shall be determined in accordance with AASHTO T 308 using the ignition furnace for each sublot. The acceptance laboratory is responsible for obtaining the necessary materials and performing an ignition furnace calibration as outlined in AASHTO T308 for each asphalt concrete mixture utilized on the project. The correction factor used for each test shall be clearly indicated on the report. The bulk density for Marshall Mix designs shall be tested in accordance with AASHTO T 245. The bulk density for Gyratory mix designs shall be tested in accordance with AASHTO T312. The maximum theoretical density shall be tested in accordance with the requirements of AASHTO T209 including fan drying per AASHTO T 209 Section 11. Effective voids determined on the laboratory compacted specimens will be determined at a minimum of once per lot in accordance with the

requirements of AASHTO T269. Should the testing for effective air voids not meet the "Full Payment" or "No Corrective Action" requirements of Table 321-5, additional testing for laboratory air voids on the remaining sublots will be performed as necessary to determine the extent of the deficiency. Acceptance testing results will be furnished to the contractor within five working days of receipt of samples by the acceptance laboratory. The acceptance laboratory shall ensure that the supplier is provided copies of all reports of acceptance testing performed on asphalt concrete samples taken to determine compliance with specifications.

During production, the allowable deviations from the mix design gradation targets are listed in the tables below. The allowable production tolerances may fall outside of the mix design gradation bands.

TABLE 321-3A
GRADATION ACCEPTANCE LIMITS FOR MARSHALL MIXES

Sieve Size	⅜ inch Mix	½ inch Mix	¾ inch Mix	Base Mix
1 inch	---	---	---	±7%
¾ inch	---	---	±7%	±6%
½ inch	---	±7%	---	---
⅜ inch	±7%	±6%	±6%	±6%
No. 8	±6%	±6%	±6%	±6%
No. 40	±4%	±4%	±4%	±4%
No. 200	±2%	±2%	±2%	±2%

TABLE 321-3B
GRADATION ACCEPTANCE LIMITS FOR GYRATORY MIXES

Sieve Size	⅜ inch Mix	½ inch Mix	¾ inch Mix
¾ inch	---	---	±7%
½ inch	---	±7%	±6%
⅜ inch	±7%	±6%	---
No. 8	±6%	±6%	±6%
No. 40	±4%	±4%	±4%
No. 200	±2%	±2%	±2%

If the results from a single acceptance sample fall outside of the acceptance limits in Table 321-3 a second sample shall be taken and if the second acceptance sample is also outside of the acceptance limits in Table 321-3 the Contractor shall cease production of asphalt concrete. Production shall not begin again until calibration test results verify that adjustments made to materials or proportions yield a gradation that falls within acceptance limits in Table 321-3.

If the asphalt binder content is within ± 0.40% of the mix design target value, the asphalt concrete will be paid for at the contract unit price. If the asphalt binder content deviates by more than ± 0.40% from the mix design target value, the deficient area will be evaluated within the sublot by coring at maximum intervals of 100 feet from the deficient sample. The asphalt content of the original deficient sample will be averaged with the asphalt binder content of the cores taken for re-evaluation to determine compliance with the acceptance requirements. If the resulting average of the asphalt binder content deviates by more than ± 0.40% from the mix design target value, then Table 321-4 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

TABLE 321-4

ASPHALT BINDER CONTENT ACCEPTANCE AND PENALTIES

Deviation from that permitted	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Over 0.0 to 0.1% points	$2.00	EA (see 321.10.6)
Over 0.1 to 0.2% points	$6.00	EA (see 321.10.6)
Over 0.2% points	Removal* or EA per 321.10.6	Removal* or EA per 321.10.6

If the laboratory air voids fall within a range of 2.8% to 6.2%, the asphalt concrete will be paid for at the contract unit price. If the laboratory air voids are outside of this range, the deficient area will be evaluated within the sublot by coring at maximum intervals of 100 feet from the deficient sample. The laboratory air voids of the original deficient sample will be averaged with the laboratory air voids obtained from each of the cores taken for re-evaluation to determine compliance with the acceptance requirements. If the resulting average of the laboratory air voids is outside the indicated range, then Table 321-5 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

TABLE 321-5		
LABORATORY VOIDS ACCEPTANCE AND PENALTIES		
Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Less than 1.5%	Removal* or EA per 321.10.6	Removal* or EA per 321.10.6
1.5-2.0%	$2.50	EA (see 321.10.6)
2.1-2.7%	$1.00	EA (see 321.10.6)
2.8-6.2%	Full Payment	No corrective action
6.3-6.9%	$1.00	EA (see 321.10.6)
7.0-8.0%	$2.50	EA (see 321.10.6)
Greater than 8.0%	Removal* or EA per 321.10.6	Removal* or EA per 321.10.6

If an agency or Engineer is purchasing asphalt concrete directly from a commercial material supplier, the agency or Engineer will use Section 321.10 and specifically Tables 321-3, 321-4 and 321-5 from Section 321.10 when determining the acceptance of the asphalt concrete with the material supplier.

321.10.3 Surface Testing: If directed by the Engineer surface drainage test shall be performed. The completed surfacing shall be thoroughly compacted, smooth and true to grade and cross-section and free from ruts, humps, depressions or irregularities. An acceptable surface shall not vary more than 1/4 inch from the lower edge of a 12-foot straightedge when the straightedge is placed parallel to the centerline of the roadway. The straightedge shall be furnished by the contractor and shall be acceptable to the Engineer.

All streets shall be water tested for drainage in the presence of the Engineer or designated representative before final acceptance. Any areas not draining properly shall be corrected to the Engineer's satisfaction at the Contractor's expense. Water for this testing shall be provided and paid for by the Contractor.

When deviations in excess of the above tolerance are found, humps or depressions shall be corrected to meet the specified tolerance, or shall be cut out along neat straight lines and replaced with fresh hot mixture and thoroughly compacted to conform with and bond to the surrounding area. Materials and work necessary to correct such deviations shall be at no additional cost to the Contracting Agency.

321.10.4 Asphalt Pavement Thickness: Asphalt Pavement thickness will be determined from cores secured from each sublot for this purpose. Such cores will be taken and measured by the Asphalt Concrete Coring Method. This method can be found at in Section 321.14. Each core location will be patched by the party responsible for the testing.

If the pavement thickness is deficient from the target thickness by 0.25 inches or less, it will be paid for at the contract unit price. If the pavement thickness deficiency is greater than 0.25 inches and the contracting agency is not the owner (i.e. permits) the following steps will apply:

(1) If the thickness deficiency of the pavement exceeds 0.25 inch, the limits of the deficient area will be evaluated by coring at maximum intervals of 100 feet from the deficient core. The thicknesses of the original deficient core will be averaged with the thicknesses of the cores taken from 100 feet on each side of it to determine compliance with the acceptance requirements. If the resulting average thickness deficiency is greater than 0.25 inch, then Table 321-6 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

(2) If the pavement thickness from step one above deviates from the target thickness by more than 0.25 inch but not more than 0.50 inch, corrective action will be required. This corrective action will consist of application of a Type II slurry seal coat in accordance to Section 715. The Contractor may present an engineering analysis outlining other proposed remedial measures for the consideration of the Engineer. The Engineer will review the engineering analysis and decide within 30 working days whether to accept the proposed remedial measures.

(3) If the pavement thickness from step one above deviates from the target thickness by more than 0.50 inch, corrective action will be required. The deficient area will be overlaid with no less than 1 inch thick lift, for the full width of the pavement to meet or exceed the designed thickness, with the appropriate end and edge milling, with a mixture approved by the Engineer. The Contractor may present an engineering analysis outlining other proposed remedial measures for the Engineer's consideration. The Engineer will review the engineering analysis and decide within 10 working days whether to accept the proposed remedial measures. If the Engineer chooses to reject the engineering analysis, the indicated overlay will be constructed by the Contractor at no additional cost to the Owner.

If the pavement thickness deficiency is greater than 0.25 inches and the contracting agency is the owner, Table 321-6 will apply.

TABLE 321-6	
ASPHALT PAVEMENT THICKNESS PAYMENT REDUCTION **For Thickness Deficiency of More Than 0.25 inches and less than 0.50 inches**	
Specified Pavement Thickness	**Reduction in Payment or Corrective Action**
Less than 1.5 inches	50%
1.50 inches to 1.99 inches	33%
2.00 inches to 2.49 inches	25%
2.50 inches to 2.99 inches	20%
3.00 inches and over	17%

321.10.5 Density:

321.10.5.1 Pavement Thickness 1-1/2 Inches or Less in Nominal Thickness:

SECTION 323

Compaction shall consist of a "Rolling Method Procedure" using an established sequence of coverage with specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as shown in Table 321-7.

TABLE 321-7				
ROLLING SEQUENCE FOR LIFT THICKNESS 1½" OR LESS				
Rolling Sequence	**Type of Compactor**		**No. of Coverages**	
	Option No. 1	**Option No. 2**	**Option No.1**	**Option No. 2**
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2- 4*
Finish	Static Steel	Static Steel	1-3	1-3
* Based on the roller pattern which exhibits the best performance.				

The **Contractor** shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure. Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F. Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

321.10.5.2 Pavement Thickness Greater than 1-1/2 Inches in Nominal Thickness:

Achieving the required compaction is the responsibility of the contractor. The number and types of rollers is the contractor's responsibility and shall be sufficient to meet these requirements.

In-place air voids shall be determined in accordance with AASHTO T269 utilizing cores taken from the finished pavement. The maximum theoretical density used in the determination of in-place air voids will be the average value from the acceptance samples determined for the Lot as outlined in 321.10.1.

The Engineer will designate one random test location for each sublot and the acceptance laboratory will obtain one core from that location. The outside one foot of each pass of the pavement course or any unconfined edge will be excluded from testing. The Engineer may exclude areas from the compaction lot that are not accessible by normal compaction equipment.

The Contractor will provide the traffic control to facilitate any coring operations necessary for compaction acceptance.

Cores will be taken per the Asphalt Concrete Coring Method. This method can be found in Section 321. 14. Acceptance testing results will be furnished to the contractor within five working days of receipt of samples by the acceptance laboratory.

If the pavement density has in-place voids of 8.0% or less, the asphalt concrete will be paid for at the contract unit price. If the pavement density has in-place voids greater than 8.0%, the deficient area will be evaluated within the sublot by coring at maximum intervals of 100 feet from the deficient core(s). If both cores in a sublot are deficient, 3 to 4 additional cores may be necessary to re-evaluate acceptance. The in-place voids of all the original core**(s),** whether deficient or acceptable, will be averaged with the in-place voids of the cores taken for re-evaluation to

determine compliance with the acceptance requirements. If the average of the in-place voids is greater than 8.0% then Table 321-8 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

TABLE 321-8		
PAVEMENT DENSITY PENALTIES		
Limits of In-place Air Voids for lift thicknesses greater than 1.5 inches	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
8.1% to 9.0%	$4.00	EA
9.1% to 10.0%	$6.00	EA and Type II Surry Seal
10.1% to 11.0%	Removal* or EA per 321.10.6	Removal* or EA per 321.10.6
Greater than 11.0%	Removal	Removal

Notes: Removal refers to Section 321.10.6. The Contractor shall remove and replace the entire sublot that is deficient. Removal for In-place Air Voids greater than 11.0% is not eligible for Section 321.10.6.

321.10.6 Engineering Analysis (EA): Within 10 working days after receiving notice that a lot or sublot of asphalt concrete is deficient and is found to fall within the "Removal or EA" band per Table(s) 321-4, 321-5, and/or 321-8 the contractor may submit a written proposal (Engineering Analysis) to accept the material in place at the applicable penalties along with possible remediation(s) listed in the "Removal or EA" category. Engineering Analysis can also be proposed for non-removal categories of "Corrective actions" when the contracting agency is not the owner (i.e. permits).

The Engineering Analysis shall contain an analysis of the anticipated performance of the asphalt concrete if left in place. The Engineering Analysis shall also detail the effect of any proposed corrective action to the material(s) in place as it relates to the in-place material's performance. The Engineering Analysis shall be performed by a professional engineer experienced in asphalt concrete testing and mix designs. If the lot or sublot is submitted for referee testing by the contractor, the ten working days allowed to prepare an engineering will begin upon notification of referee test results.

When an Engineering Analysis recommends that a specific lot or sublot should not be removed, the Engineering Analysis will recommend that the following penalties (Table 321-9) be paid when the contracting agency is the owner, for the specific criteria being reviewed by the EA.

TABLE 321-9		
ENGINEERING ANALYSIS PENALTIES for REMOVAL* LOTS/SUBLOTS LEFT IN-PLACE		
Acceptance Criteria	**Acceptance Limits**	**Penalty When Contracting Agency is the Owner ($/Ton)**
Asphalt Binder Content	Over 0.2% points from that Permitted	$9.00
Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	Less than 1.5% or Greater Than 8.0%	$3.75

Limits of In-place Air Voids	10.1% to 11.0%	$9.00

Within 15 working days, the Engineer will determine whether or not to accept the contractor's proposed Engineering Analysis.

321.11 REFEREE:

In the event the contractor elects to question the acceptance test results for either asphalt binder content, laboratory air voids, density or a combination thereof for a sublot, the Contractor may make a written request for additional testing of that sublot. Any request for referee testing must describe the contractor's reasons for questioning the validity of the original acceptance results and must clearly describe which set of acceptance tests are in question. The Contractor will engage an independent laboratory (at the Contractors own expense) who is accredited by AAP in all of the acceptance test methods. The independent laboratory shall be acceptable to the Engineer and shall perform a new set of acceptance tests as required by Section 321.10 representing the area or set of tests in question. The results of these determinations will be binding on both the contractor and the agency.

These tests may include asphalt binder content, aggregate gradation, Marshall or Gyratory unit weight, maximum theoretical unit weight, laboratory air voids and in-place air voids (compaction). Samples for referee testing shall come from representative samples obtained from the completed pavement, as directed by the Engineer.

The number of samples taken will be the same as specified in Section 321.10. The independent laboratory shall compile the test results and transmit them to both the Engineer and the contractor. The independent laboratory shall include a report signed by an Engineer registered in the State of Arizona, who is experienced in asphalt concrete testing and mix design development. The signed report shall give an opinion that the material evaluated does or does not comply with project specifications, shall clearly describe any deficiencies, and the results will be binding between all parties.

321.12 MEASUREMENT:

Asphalt concrete pavement will be measured by the ton, or by the square yard, for the mixture actually used as allowed above, which shall include the required quantities of mineral aggregates, asphalt binder, and mineral admixture. Measurement shall include any tonnage used to construct intersections, roadways, streets, or other miscellaneous surfaces indicated on the plans or as directed by the Engineer.

321.13 PAYMENT:

The asphalt concrete measured as provided above will be paid for at the contract price per ton or square yard, as adjusted per Section 321.10, which price shall be full compensation for the item complete, as herein described and specified.

Payment for tack coat will be by the ton diluted, based on the rate of application, as directed by the Engineer.

No payment will be made for any overrun in quantity of asphalt concrete in excess of 10 percent based on actual field measurement of area covered, design thickness, and the mix design unit weight. The calculations and payment for overrun will be by individual pay item. To compensate or adjust for a thickness deficiency in an underlying asphalt concrete course, the Engineer may authorize a quantity increase in excess of 10 percent for a subsequent asphalt concrete course. In such cases, the quantity in excess of 10 percent will be paid for at the lowest unit price.

Except as otherwise specified in the special provisions, no separate payment will be made for work necessary to construct miscellaneous items or surfaces of asphalt concrete.

321.14 ASPHALT CORE METHOD: Core Drilling of Hot Mix Asphalt (HMA) for Specimens of 4" or 6" diameter

SECTION 323

321.14.1 Scope: This method is to establish a consistent method of the use of a diamond bit core to recover specimens of 4 or 6 inch diameter for laboratory analysis and testing. The method will require the use of: water, ice (bagged or other suitable type), dry ice, and a water-soap solution to be utilized when coring asphalt rubber concrete. Individuals doing the specimen recovery should be observing all safety regulations from the equipment manufacturer as well as the required job site safety requirements for actions, and required personal protective equipment.

321.14.2 Core Drilling Device: The core drilling device will be powered by an electrical motor, or by an acceptable gasoline engine. Either device used shall be capable of applying enough effective rotational velocity to secure a drilled specimen. The specimen shall be cored perpendicularly to the surface of pavement, and that the sides of the core are cut in a manner to minimize sample distortion or damage. The machinery utilized for the procedure shall be on a mounted base, have a geared column and carriage that will permit the application of variable pressure to the core head and carriage throughout the entire drilling operation. The carriage and column apparatus shall be securely attached to the base of the apparatus; and the base will be secured with a mechanical fastener or held in place by the body weight of the operator. The core drilling apparatus shall be equipped with a water spindle to allow water to be introduced inside of the drill stem while operating. The cutting edge of the core drill bit shall be of hardened steel or other suitable material with embedded diamond chips in the cutting surface. The core barrel shall be of sufficient diameter to secure a specimen that is a minimum of four or six inches or whichever is prescribed for necessary testing. The core barrel shall not be missing more than one of the teeth used for cutting; if so it shall be discarded and another barrel shall be used. The core barrel shall also be a minimum of two inches longer than the anticipated depth of pavement in accordance with project paving plans.

321.14.3 Accessory Equipment: A sufficient supply of ice and dry ice shall be provided to sufficiently cool the pavement prior to securing the samples from the designated areas in the pavement. The ice should also be used to adjust the temperature of the water used to cool the core bit. A water supply (usually a plastic 35 – 55 gal drum) with sufficient hose to introduce the water into and through the spindle of the coring device by gravity feed. The drum should be white or light in color to minimize excessive thermal heating of the water (*for coring of asphalt rubber cores see Note 1*). At no time shall the water utilized in the coring operation exceed 65° F during the coring operation. Ice shall be utilized o ensure the temperature control of the water being introduced during the cutting operation. An ice chest or other suitably insulated container that can maintain a temperature of less than 70° F shall be used to secure the specimens during transport. The container will be equipped with flat shelving that will support the drilled cores throughout the entire specimen dimension during transport back to the testing facility.

Miscellaneous hand tools to remove the drilled specimen from the drill hole or the core barrel taking great care in not disturbing the specimen more than necessary (refer to fig. 1 in ASTM D 5361-05).

321.14.4 Process: The pavement surface at the time of coring shall not exceed a temperature of 90° F, the pavement shall be conditioned with ice or dry ice to ensure that this requirement is met. Immediately after it has been ensured that the pavement has dropped to the required temperature, core drilling shall begin. The operator will then apply an even and continuous pressure (Note 2) to penetrate through the full depth of the pavement. The operator will concurrently ensure that enough water is moving over the core surface as to adequately remove any and all cuttings that could damage the drilled core. After the pavement thickness has been penetrated the core shall be carefully removed from either the drill hole or the core barrel and be immediately transferred to an ice chest or other suitable container. Each individual core shall be placed on a shelf in the cooler with the exposed side of the specimen facing down, or the "top side" down. If the specimen is a two lift core, the only acceptable means of separating lifts is with a power or other acceptable wet saw type of equipment (conforming to ASTM D 5361-05); however, at no time shall cores be split using a mallet and screwdriver or metal straight edge when being tested for bulk density. Perpendicularity of the specimen shall be checked in the field after the specimen has been extracted from the surface. The core operator shall hold the core up to eye level and place the core top side down in a "speed square" or small carpenters square. The specimen placed in the square shall not depart from perpendicular to the axis more than 0.5^{o} (approximately equivalent to 1/16 of an inch in 6 inches). If the specimen is outside of this distance from square it shall be discarded in the field and another sample cored that falls within tolerance. The cores upon arriving at the laboratory for testing shall be carefully cleaned and measured for thickness in accordance with ASTM D 3549. A speed square shall be utilized to measure squareness as compared to a 90° degree angle and shall not depart from

perpendicular to the axis more than 0.5^{o} (approximately equivalent to 1/16 of an inch in 6 inches). All remaining testing shall be done within the parameters of the current project and / or agency required specification.

Date: July 15, 2011

To: MAG Specification and Detail Committee members

From: Jeff Benedict

RE: case 11-24 section 337 “Crack sealing”

Purpose: To add an updated section with clear limits of its use and scope of crack sealing. The MAG did not have any specifications for crack sealing. Crafco, a major vendor was consulted and helped write the specification. We then reviewed it and had agency members review.
This reflects a major change to the current MAG section.

SECTION 337

CRACK SEALING AND CRACK FILLING

337.1 GENERAL:

This work shall consist of an application of hot applied, single component polymer modified asphalt rubber, supplied in solid form used to seal or fill cracks or joints in asphalt concrete or portland cement concrete pavements. Cracks or joints that will be sealed shall be a minimum of ¼ inch wide at time of work, and have a maximum width of 1 inch.

The work involves furnishing and placing all materials on existing pavement surfaces in accordance with this specification.

337.2 MATERIALS:

Materials shall be a premixed, single component mixture of asphalt cement, aromatic extender oils, polymers, and granulized rubber in a closely controlled manufacturing process. Materials will conform to the following specifications when heated in accordance to ASTM D5078 to the manufactures maximum safe heating temperatures.

Test	Specification
Cone Penetration (ASTM D5329)	20-40
Resilience (ASTM D5329)	30% Minimum
Softening Point (ASTM D113)	210°F (99°C) Minimum
Ductility, 77F (25C) (ASTM D113)	30 cm Minimum
Flexibility (ASTM D3111 *Modified)	Pass at 30°F (-1°C)
Flow 140°F (60°C) (ASTM D5329)	3 mm Maximum
Brookfield Viscosity, 400°F (204°C) (ASTM D2669)	100 Poise Maximum
Asphalt Compatibility (ASTM D5329)	Pass
Bitumen Content (ASTM D4)	60% Minimum
Tensile Adhesion (ASTM D5329)	400% Minimum
Maximum Heating Temperature	400°F (204°C)
Minimum Heating Temperature	380°F (193°C)

*Specimen bent 90° over a 1-inch mandrel within 10 seconds

337.2.1 Certification and Quality Assurance: Prior to application, the Contractor shall submit certification of compliance to the Engineer for all materials to be used in the work.

337.3 EQUIPMENT:

The melter applicator unit shall be a self-contained double boiler device with the transmittal of heat through heat transfer oil. It must be equipped with an on board automatic heat controlling device to permit the attainment of a predetermined temperature, and then maintain that temperature as long as required. The unit shall also have a means to vigorously and continuously agitate the sealant to meet the requirements of Appendix X1.1 of ATSM D6690. The sealant shall be applied to the pavement under pressure supplied by a gear pump with a hose and wand and direct connecting applicator tip. The pump shall have sufficient pressure to apply designated sealant at a rate of at least three (3) gallons (11.4 L) per minute. Melter applicators shall be approved for use by the sealant manufacturer.

337.4 APPLICATION:

The sealant shall be applied in the crack or joint reservoir uniformly from bottom to top and shall be filled without formation of entrapped air or voids.

The crack or joint shall be slightly overfilled then leveled with a 3” sealing disk or v-shaped squeegee to create a neat band aid extending ± 1” on each side of the crack or joint for surface strength and waterproofing. The band aid shall not be more than 1/8 inch in thickness above the pavement surface.

If the pavement being sealed will be overlaid with Hot Mix Asphalt within six months of sealant application, cracks shall be routed, and sealant placement shall be recessed ¼" (6 mm) in the crack or joint reservoir with no over band. If routing is not used, the sealant over band thickness and width should be kept as narrow and thin as possible.

337.5 CLEANING AND PREPARING CRACKS OR JOINTS:

Prior to application of polymer modified asphalt rubber, all cracks or joints shall be cleaned out of any debris and dust. As directed by the Engineer, final cleaning of the cracks or joints shall be vacuumed. Routing Cracks and joints will extend crack sealant life and performance. Most cracks in Maricopa County have less than 1/8" movement over the course of a year. On cracks that have spacing which creates more than 1/8" movement it is recommended that cracks be routed.

337.5.1 Routing:

Routing, when specified, is incidental work and is included the project cost. Routing the cracks should be used to create a sealant reservoir. Cutting should remove at least 1/8" (3 mm) from each side and produce vertical, intact surfaces with no loosely bonded aggregate. Joints and cracks should be routed to a ¾" (19mm) W x ¾" (19mm) D configuration for a typical application.

337.5.2 Vacuuming:

Final cleaning shall thoroughly clean cracks and joints to a minimum of 1". The vacuum unit shall use high pressure 90 psi (620 kPa) minimum, dry, oil free compressed air to remove any remaining dust, directly attached to a vacuum unit to collect the dust and residue. Both sides of the crack or joint shall be cleaned. Surfaces will be inspected to assure adequate cleanliness and dryness.

337.6 OPENING TO TRAFFIC:

Material shall not be exposed to traffic until fully cured. If sealed area must be open to traffic a blotter material can be applied to surface of polymer modified asphalt rubber.

337.6.1 Blotter:

On two lane roads or where traffic may be likely to come in contact with the hot sealant before it cures, a blotter or specialized bond breaking material may be required to prevent asphalt bleeding and/or pickup of sealant by vehicular traffic. Blotter material should be compatible with crack sealant and any surface treatment being used.

337.7 PAVEMENT TEMPERATURES

Polymer modified asphalt rubber shall be applied when pavement temperature exceeds 40°F (4°C). Lower temperatures may result in reduced adhesion due to the presence of moisture or ice. If pavement temperature is lower that 40°F (4°C), it may be warmed using a heat lance that puts no direct flame on the pavement. If installing at lower pavement temperatures that 4 0°F (4°C), ex treme ca re s hould b e u sed t o i nsure t hat cr acks o r j oints ar e d ry an d f ree from i ce a nd o ther contaminates. P roduct t emperatures s hould b e maintained at t he maximum heating t emperature r ecommended by t he manufacture. If installing at night, ensure that dew is not forming on the pavement surface. Applied product should be checked by qualified personnel to ensure that adhesion is adequate.

337.8 MEASUREMENT:

The cleaning and sealing of cracks and joints shall be measured by pounds of sealant placed.

337.9 PAYMENT:

Payment will be full compensation for furnishing and placing all materials specified and used, with no allowance for waste, and shall include labor, equipment, tools, and incidentals to complete the work as prescribed and as directed by the Engineer.

No payment will be made for materials rejected due to improper placement, improper proportions of materials, or material found to be defective or out of specifications.

SECTION ~~336~~337

Crack Sealing and Crack Filling

~~336~~337.1 GENERAL:

This work shall consist of an application of hot applied, single component polymer modified asphalt rubber, supplied in solid form used to seal or fill cracks or joints in asphalt concrete or portland cement concrete pavements. Cracks or joints that will be sealed shall be a minimum of ¼ inch wide at time of work, and have a maximum width of 1~~-1/2~~ inch~~es~~. ~~wide~~.

The work involves furnishing and placing all materials on existing pavement surfaces in accordance with this specification.

~~336~~337.2 MATERIALS:

Materials shall be a premixed, single component mixture of asphalt cement, aromatic extender oils, polymers, and granulized rubber in a closely controlled manufacturing process. Materials will conform to the following specifications when heated in accordance to ASTM D5078 to the Manufactures maximum safe heating temperatures.

Test	Specification
Cone Penetration (ASTM D5329)	20-40
Resilience (ASTM D5329)	30% Minimum
Softening Point (ASTM D113)	210°F (99°C) Minimum
Ductility, 77F (25C) (ASTM D113)	30 cm Minimum
Flexibility (ASTM D3111 *Modified)	Pass at 30°F (-1°C)
Flow 140°F (60°C) (ASTM D5329)	3 mm Maximum
Brookfield Viscosity, 400°F (204°C) (ASTM D2669)	100 Poise Maximum
Asphalt Compatibility (ASTM D5329)	Pass
Bitumen Content (ASTM D4)	60% Minimum
Tensile Adhesion (ASTM D5329)	400% Minimum
Maximum Heating Temperature	400°F (204°C)
Minimum Heating Temperature	380°F (193°C)

*Specimen bent 90° over a 1-inch mandrel within 10 seconds

~~336~~337.2.1 CERTIFICATION AND QUALITY ASSURANCE:

Prior to application, the Contractor shall submit certification of compliance to the Engineer for all materials to be used in the work.

~~336~~337.3 EQUIPMENT:

The melter applicator unit shall be a self-contained double boiler device with the transmittal of heat through heat transfer oil. It must be equipped with an on board automatic heat controlling device to permit the attainment of a predetermined temperature, and then maintain that temperature as long as required. The unit shall also have a means to vigorously and continuously agitate the sealant to meet the requirements of Appendix X1.1 of ATSM D6690. The sealant shall be applied to the pavement under pressure supplied by a gear pump with a hose and wand and direct connecting applicator tip. The pump shall have sufficient pressure to apply designated sealant at a rate of at least three (3) gallons (11.4 L) per minute. Melter applicators shall be approved for use by the sealant manufacturer.

~~336~~337.4 APPLICATION:

The sealant shall be applied in the crack or joint reservoir uniformly ~~solid~~ from bottom to top and shall be filled without formation of entrapped air or voids.

The crack or joint shall be slightly overfilled then leveled with a 3" sealing disk or v-shaped squeegee to create a neat band aid extending ± 1" on each side of the crack or joint for surface strength and waterproofing. The band aid shall not be more than 1/8 inch in thickness above the pavement surface.

If the pavement being sealed will be overlaid with Hot Mix Asphalt within six months of sealant application, cracks shall be routed, and sealant placement shall be recessed ¼" (6 mm) in the crack or joint reservoir with no over band. If routing is not used, the sealant over band thickness and width should be kept as narrow and thin as possible.

~~336~~337.5 CLEANING AND PREPARING CRACKS OR JOINTS:

Prior to application of polymer modified asphalt rubber, all cracks or joints shall be cleaned out of any debris and dust. As directed by the Engineer, final cleaning of the ~~Cracks~~ cracks or joints shall be ~~cleaned by blowing or~~ vacuumed~~ing~~. Routing Cracks and joints ~~may~~will~~will~~ extend crack sealant life and performance. Most cracks in Maricopa County have less than 1/8" movement over the course of a year. On cracks that have spacing which creates more than 1/8" movement it is recommended that cracks be routed.

~~336~~337.5.1 ROUTING:

~~Routing~~Routing, when specified, is incidental work and is included the project cost. Routing the cracks ~~operation~~ should be used to create a sealant reservoir. Cutting should remove at least 1/8" (3 mm) from each side and produce vertical, intact surfaces with no loosely bonded aggregate. Joints and cracks should be

routed to a ¾" (19mm) W x ¾" (19mm) D configuration for a typical application. ~~A low profile configuration of 1 ½" (40mm) W x 3/8" (10mm) D may be used in colder climates however studies also suggest a 2:1 maximum ratio for enhanced thermal movement performance. If crack sealing is performed on a previously chip sealed or slurried surface, the low profile configuration depth should be 5/8" (15mm) D. The pavement should be sound enough to resist significant spalling during cutting. Final reservoir width should not exceed twice the cutter width or 1 ½" (38mm) maximum.~~

~~336~~337.5.2 BLOWING:

~~Final cleaning shall use high pressure 90 psi (620 kpakPa) minimum, dry, oil free compressed air to remove any remaining dust. Both sides of the crack or joint shall be cleaned. Surfaces will be inspected to assure adequate cleanliness and dryness.~~

~~336~~337.5.2~~3~~ VACUUMING:

Final cleaning shall thoroughly clean cracks and joints to a minimum of 1". The vacuum unit shall use high pressure 90 psi (620 ~~kpa~~kPa) minimum, dry, oil free compressed air to remove any remaining dust, directly attached to a vacuum unit to collect the dust and residue. Both sides of the crack or joint shall be cleaned. Surfaces will be inspected to assure adequate cleanliness and dryness.

~~336~~337.6 OPENING TO TRAFFIC:

Material shall not be exposed to traffic until fully cured. If sealed area must be open to traffic a blotter material can be applied to surface of polymer modified asphalt rubber.

~~336~~337.6.1 BLOTTER:

On two lane roads or where traffic may be likely to come in contact with the hot sealant before it cures, a blotter or specialized bond breaking material~~detackifying material~~ may be required to prevent asphalt bleeding and/or pickup of sealant by vehicular traffic. Blotter material should be compatible with crack sealant and any surface treatment being used.

Comment [pdf1]: We need a better word here. This sounds too tacky.

~~336~~337.7 PAVEMENT TEMPERATURES

Polymer modified asphalt rubber shall be applied when pavement temperature exceeds 40°F (4°C). Lower temperatures may result in reduced adhesion due to the presence of moisture or ice. If pavement temperature is lower that 40°F (4°C), it may be warmed using a heat lance that puts no direct flame on the pavement. If installing at lower pavement temperatures that 40°F (4°C), extreme

care should be used to insure that cracks or joints are dry and free from ice and other contaminates. Product temperatures should be maintained at the maximum heating temperature recommended by the manufacture. If installing at night, ensure that dew is not forming on the pavement surface. Applied product should be checked by qualified personnel to ensure that adhesion is adequate.

~~336~~337.8 MEASUREMENT:

The cleaning and sealing of cracks and joints shall be measured by pounds of sealant placed.~~the lineal foot.~~

~~336~~337.9 PAYMENT:

Payment will be full compensation for furnishing and placing all materials specified and used, with no allowance for waste, and shall include labor, equipment, tools, and incidentals to complete the work as prescribed and as directed by the Engineer.

No payment will be made for materials rejected due to improper placement, improper proportions of ~~materials. Or~~materials, or material found to be defective or out of specifications.

P.O. Box 52025
Phoenix, AZ 85072-2025
(602) 236-5900

Case 11-29

DATE: August 7, 2011

TO: MAG Specifications and Details Committee Members

FROM: Peter Kandaris, SRP Representative

RE: **Revisions to Section 701 – Rock, Gravel and Sand**

Purpose: Update standard identified by Outside ROW WG

Revisions: The purpose of the changes are to consolidate general aggregate material requirements within Section 701, move specific material requirements to appropriate material sections, remove archaic test methods or processes that are not longer practiced by the industry, and replace subjective material requirements with accepted test methods.

Major changes are summarized below:

(a) Describe coarse and fine aggregates using ASTM definitions and specifications. Unless a test is general to all aggregates, move material-specific test requirement to specific sections. Delete generic descriptions of materials that are vague and use ASTM definitions standard in the industry.

(b) Change title to “Aggregate”.

(c) Move LA abrasion test requirements to specific sections (see attached diagram).

(d) Allow recycled materials upon approval of the Engineer.

(e) Sand requirement for asphalt concrete (sand equivalent) is already in Section 710.

(f) Move sand for concrete to Section 725 (see attached change to 725).

(g) Move sand for CLSM to Section 728 (see attached change to 728).

(h) Move sand for mortar & grout to Section 776 (see attached change to 776).

(i) Deleted plaster since it is not referenced as a material in other MAG sections or details. The term “plaster” is incorrectly used in a number of details and one section. These will be changed to “mortar” in Case 11-01 (miscellaneous items) this year.

(j) Delete quarry stone requirements. Section 701.4 primarily describes the Rock Drop Test, but the test is not done nor is it safe. Keep the specific gravity requirement, but change the minimum to 2.50 to be consistent with local materials and ADOT values.

(k) In addition to the changed sections already noted, other sections that refer to Section 701 to be modified include (changes attached): 206, 220 (also part of Case 11-31), 325 (also part of Case 11-22), 333, 603, 604, 605, 620, 714, 715 (also part of Case 11-26), 716 (also part of Case 11-28) and 736.

(l) References to ASTM or AASHTO standards have been made more uniform.

SECTION 701 – REVISED 8-17-11

AGGREGATE

701.1 GENERAL:

Coarse and fine aggregates are defined in accordance ASTM D-2487. Material property requirements for specific uses are provided in applicable MAG sections.

701.2 COARSE AGGREGATE:

Rock and gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance. Aggregate sources shall include, but not be limited to alluvial deposits, terrace aggregates, quarry stone, or other suitable sources including recycled products that meet all material test requirements as approved by the Engineer. Aggregate classification shall be made by size as noted herein.

Apparent specific gravity shall be at least 2.~~65~~50, when tested in accordance with ASTM C-127.

701.2.1 Boulders: Particles of rock that will not pass a 12-inch square opening.

701.2.2 Cobbles: Particles of rock that will pass a 12-inch square opening, but are retained on a 3-inch square opening.

701.2.3 Coarse Gravel: Particles of rock that will pass a 3-inch U.S. standard sieve, but are retained on a 3/4-inch U.S. standard sieve.

7.01.2.4 Fine Gravel: Particles of rock that will pass a 3/4-inch U.S. standard sieve, but are retained on a No. 4 U.S. standard sieve

701.3 FINE AGGREGATE (SAND):

Fine aggregate (sand) shall be fine granular material produced by the crushing of rock or gravel or naturally produced by disintegration of rock and shall be sufficiently free of organic material, mica, loam, clay, and other deleterious substances to be thoroughly suitable for the purpose for which it is intended. Fine aggregates particles shall pass a No. 4 U.S. standard sieve, but are retained on a No. 200 U.S. standard sieve.

701.4 SAMPLING ~~AND TESTING~~:

Samplings ~~and sieve analysis~~ of aggregates shall be performed in accordance with ASTM D-75 ~~and ASTM C-136~~.

SECTION 701
AGGREGATE:
~~ROCK, GRAVEL, AND SAND~~

701.1 GENERAL:

~~The following specifications set forth the requirements for crushed rock, gravel, sand, and quarry stone.~~ Samplings ~~and sieve analysis~~ shall be performed in accordance with ASTM D-75 ~~and ASTM C-136. Sand equivalents shall be determined in accordance with AASHTO T-176. The liquid limit and plasticity index shall be determined in accordance with AASHTO T-89 and T-90.~~

Coarse and fine aggregates are defined in accordance ASTM D-2487. Material property requirements for specific uses are provided in applicable MAG sections.

Sampling moved to new 701.4.
Testing methods such as ASTM C136 are included with specific MAG sections.
SE, LL & PI as part of existing Section 701.3 are moved with the material requirements to the appropriate sections.

701.2 ~~CRUSHED ROCK AND GRAVEL:~~ COARSE AGGREGATE:

Coarse aggregate

~~Rock and gravel~~ shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

Aggregate sources shall include, but not be limited to alluvial deposits, terrace aggregates, quarry stone, or other suitable sources including recycled products that meet all material test requirements as approved by the Engineer. Aggregate classification shall be made by size as noted herein.

Moved from 701.4.2 Apparent specific gravity shall be at least ~~2.65~~ 2.50 when tested in accordance with ASTM C-127.

~~The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.~~

Delete: Requirements already in most MAG Sections. Add to 725.3 and 728.2. Grading type is dependent on material size and cannot be pre-defined for all aggregates. It is up to the testing group to determine the appropriate grading.

Delete: Gradation requirements are non-standard or contradict specific sections. Use fractured face count (ARIZ 212) for specific materials to define angularity in specific sections. ASTM D448 is eliminated since specific gradation limits are defined by materials in specific sections. Grizzly bars are rarely checked. Source is now defined in 701.2. Gravel definition is subjective and does not include specific test requirements. Replace with the following definitions of various coarse aggregate types:

701.2.1 Crushed Rock: Crushed rock shall consist of the product obtained by crushing rock, stone, or gravel so that at least 50 percent by weight of aggregate retained on the No. 4 sieve for 3/4 inch or larger maximum sizes, and 50 percent retained on the No. 8 sieve for maximum sizes less than 3/4 inch shall consist of particles which have at least one rough, angular surface produced by crushing. All material that will pass a grizzly with bars spaced 15 inches apart, clear opening, shall be crushed when producing from the Contracting Agency's source.

The gradation of crushed rock shall comply with ASTM D-448.

701.2.2 Gravel: Material designated herein as gravel shall be composed entirely of particles that are either fully or partially rounded and water-worn. Crushed rock obtained by crushing rock which exceeds ASTM D-448 maximum gradation sizes may be combined provided it is uniformly distributed throughout and blended with the gravel. The quality and gradation requirements shall be as stated in this specification.

701.2.1 Boulders: Particles of rock that will not pass a 12-inch square opening.

701.2.2 Cobbles: Particles of rock that will pass a 12-inch square opening, but are retained on a 3-inch square opening.

701.2.3 Coarse Gravel: Particles of rock that will pass a 3-inch U.S. standard sieve, but are retained on a 3/4-inch U.S. standard sieve.

7.01.2.4 Fine Gravel: Particles of rock that will pass a 3/4-inch U.S. standard sieve, but are retained on a No. 4 U.S. standard sieve.

701.3 ~~AGGREGATE:~~ FINE AGGREGATE (SAND):

Fine aggregate (sand)

~~Sand~~ shall be fine granular material produced by the crushing of rock or gravel or naturally produced by disintegration of rock and shall be sufficiently free of organic material, mica, loam, clay, and other deleterious substances to be thoroughly suitable for the purpose for which it is intended.

Fine aggregates particles shall pass a No. 4 U.S. standard sieve, but are retained on a No. 200 U.S. standard sieve.

701.3.1 Sand for Asphalt Concrete Pavement: Sand for asphalt concrete pavement shall comply with AASHTO M-29 except that grading requirements shall be deleted and have a minimum sand equivalent of not less than 50 and shall be non-plastic when tested in accordance with AASHTO T-89 and T-90.

Already in Section 710

701.3.2 Sand for Mortar and Plaster: It shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances.

Mortar moved to Section 776

The average value of sand equivalent determined on 3 successive samples shall not be less than 70. No individual sample shall have a sand equivalent less than 65.

The size and grading of sand to be used in mortar, and plaster shall be such as to conform with the requirements specified as follows:

Mortar:	ASTM C-144
Plaster:	ASTM C-35

Plaster has been deleted as it is not used in other MAG sections or details. The term "plaster" is used in Details 421 & 422 and Section 625.3.1, but the product described is actually a mortar for sewer manholes. The word is also shown on Details 501-1 & 501.2 on the outside of headwalls, but no material spec is given. The material is "plastered" on, but it is really a mortar. Word changes to these details and the section will be included in Case 11-01 as miscellaneous changes.

701.3.3 Aggregate for Portland Cement Concrete: Coarse and fine aggregate shall conform to the applicable requirements of ASTM C-33.

Moved to Section 725

Coarse aggregate grading requirements shall conform to the appropriate rock size designation in the Grading Requirements for Coarse Aggregate Table. Fine aggregate grading requirements shall conform to the Fine Aggregate Grading section.

Moved to Section 725

The average value of 3 successive sand equivalent samples shall not be less than 70 when tested in accordance with AASHTO T-176. No individual sample shall have a sand equivalent less than 65.

The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

701.3.4 Aggregate for Masonry Grout: The size and grading of the fine or coarse aggregate to be used in masonry grout shall conform to ASTM C-404.

Moved to Section 776

701.3.5 Aggregate for Controlled Low Strength Material: Coarse aggregate shall conform to ASTM C-33 grading size No. 57. The size and gradation of fine aggregates (sand) shall conform to ASTM C-33.

Moved to Section 728

701.4 QUARRY STONE:

701.4.1 General: Quarry stone shall be angular, sound, durable, hard, resistant to abrasion; free from laminations, weak cleavages, and undesirable weathering, leaching, exfoliation tendencies, and slaking; and of such character that it will not disintegrate from the action of air, water, or the conditions to be met in handling and placing. Stone shall be clean and free from deleterious impurities, including alkali, earth, clay, refuse, and adherent coatings. Suitable tests and/or service records will be used to determine the acceptability of the stone. Tests to which the material may be subjected include petrographic analysis, X-ray diffraction, specific gravity, absorption, abrasion, rock drop, soundness, wetting and drying, and such other tests as may be considered necessary to demonstrate to the Engineer that the materials are acceptable for use in the work. In connection therewith, the Contractor shall notify the Engineer in writing at least 60 days prior to use of the intended sources of quarry stone.

Delete: The main test required for quarry stone, the Rock Drop Test, is obsolete and is probably dangerous. The remaining tests are worded as suggestions (no required compliance). Most of the introductory language is repeated from Section 701.2. Sufficient new language has been added to Section 701.2 to provide engineer overview. Specific gravity requirements moved to 701.2.

701.4 SAMPLING:

Sampling of aggregates shall be performed in accordance with ASTM D-75.

701.4.2 Test Requirements: Quarry stone shall meet the following requirements except as may be otherwise provided on the plans and in the special provisions:

(A) Apparent specific gravity: 2.65 minimum.

Moved to 701.2. Note: Value reduced to 2.50 to better match local material properties. ADOT allows a minimum bulk specific gravity of 2.35, which is equivalent to a specific gravity of 2.45.

(B) Breakdown:

Rock drop breakdown:	5 percent maximum
Abrasion breakdown at 1000 revolutions:	40 percent maximum
Breakdown after 10 cycles of wetting and drying:	5 percent maximum
Solubility in water, breakdown, or softening:	None

This requirement is used for testing riprap. Moved to 703.

701.4.3 Test Methods: Unless otherwise specified in the special provisions or indicated on the plans, test methods for quarry stone shall be as follows:

(A) Apparent specific gravity per ASTM C-127.

(B) Abrasion characteristics to be determined by either Rock Drop Test or Los Angeles Rattler, ASTM C-131, as required on the plans or the special provisions.

(1) Standard Rock Drop Test. Tests shall be made on groups of 5 accurately weighed sizes of rocks: No. 1, ranging from 75 to 100 lbs.; No. 2, 100 to 125 lbs.; No. 3, 125 to 150 lbs.; No. 4, 150 to 175 lbs.; No. 5, 175 to 225 lbs.

Each rock of the 5 sizes shall be dropped 3 times on the group of the other 4, in an enclosure, from successive heights of 10, 15, and 18 feet. The enclosure shall have a flexible medium weight galvanized iron floor or equivalent, set on a solid foundation.

Order of dropping shall be Nos. 3, 2, 4, 1, 5. All rock passing a 3 inch square mesh screen after test shall be weighed and recorded

as a percentage of the total initial weight of the 5 rocks.

(2) Los Angeles abrasion machine, per ASTM C-131, Grading B.

(C) Wetting and drying. The stone shall be crushed, screened, and 1000 or 1500 grams of the 3/4 inch to 3/8 inch fraction taken for the test.

The crushed and graded stone shall be submerged in water for 18 hours at room temperature, after which the sample shall be drained and oven-dried at 140°F. When dry, the sample shall be cooled to room temperature. This would complete one cycle.

The percent loss shall be determined by screening the tested sample on a No. 4 sieve and shall be computed as follows:

$$\frac{100 \times \text{Weight of Materials Passing No. 4 Sieve}}{\text{Total Weight of Sample}} = \%\ \text{Loss}$$

(D) Accelerated water breakdown and solubility test. Air-dry samples of representative stone weighing approximately 1 lb. each shall be immersed for 8 hours at 140°F., in distilled water, local tap water, or 3.5 percent sodium chloride solution.

End of Section

manufacturer. The type of cementitious material, and the weight contained in each sack shall be plainly marked thereon.

Cementitious materials shall be stored in such manner as to permit ready access for the purpose of inspection and identification, and so as to be suitably protected against damage by contamination or moisture. Should any lot of bulk cementitious material be delivered to the site show evidence of contamination, the Engineer may require that such lot be removed from the site.

725.2.1 Supplementary Cementitious Materials (Pozzolans): Supplementary Cementitious Materials to be used in concrete or furnished under this specification shall conform to the appropriate ASTM requirements as follows:

Fly ash or natural pozzolan	ASTM C-618 and C-311
Silica Fume	ASTM C-1240

Up to 25 percent by weight of the Table 725-1 minimum cementitious materials requirements may be an approved fly ash or natural pozzolan. Additional pozzolanic material in excess of the minimum Table 725-1 requirements may be incorporated into a concrete mix design to achieve enhanced performance, upon approval of the Engineer.

The Contractor shall obtain and deliver to the Engineer a certification of compliance signed by the pozzolan supplier identifying the pozzolanic material and stating the pozzolan delivered to the batching site complies with the appropriate specifications. The cost of furnishing tested pozzolan shall be considered as included in the contract bid price and no additional allowance will be made therefore.

Pozzolanic materials shall be handled and stored in the same manner as other cementitious materials. When facilities for handling a bulk pozzolan are not available, the pozzolan shall be delivered in original unopened sacks bearing the name and brand of the supplier, the type and source of the pozzolan, and the weight contained in each sack plainly marked thereon.

725.3 AGGREGATES: **(Note: transferred from Section 701.3.3 without change)**

Coarse and fine aggregate shall conform to the applicable requirements of ASTM C-33.

Coarse aggregate grading requirements shall conform to the appropriate rock size designation in the Grading Requirements for Coarse Aggregate Table. Fine aggregate grading requirements shall conform to the Fine Aggregate Grading section.

The average value of 3 successive sand equivalent samples shall not be less than 70 when tested in accordance with AASHTO T-176. No individual sample shall have a sand equivalent less than 65.

The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

~~Coarse aggregates, consisting of crushed rock or gravel or a combination thereof, and fine aggregate shall conform to the requirements prescribed in Section 701.3.3.~~ Prior to the delivery of the aggregates and whenever required during concrete production, the Contractor shall make stockpiles available to the Engineer for testing. All required samples shall be furnished at the expense of the Contractor, and the cost of sampling and testing shall be at the expense of the Contracting Agency.

725.4 WATER:

The water used for mixing concrete shall be potable or shall meet the requirements of ASTM C-1602, when tested by a qualified independent testing laboratory.

725.5 ADMIXTURES AND ADDITIVES:

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SECTION 728 – REVISED 7/20/11

CONTROLLED LOW STRENGTH MATERIAL

728.1 GENERAL:

Controlled Low Strength Material (CLSM) is a mixture of cementitious materials, aggregates, admixtures\additives, and water that, as the cementitious materials hydrate, forms a soil replacement. CLSM is a self-compacting, flowable, cementitious material primarily used as a backfill, structural fill, or a replacement for compacted fill or unsuitable native material. Placement and usage of each type of CLSM is described in Section 604,

728.2 MATERIALS: (Note: transferred from Section 701.3.5 without change)

Cementitious materials shall conform to Section 725.2.
~~Coarse and fine aggregates shall conform to Section 701.3.5~~
Coarse aggregate shall conform to ASTM C-33 grading size No. 57. The size and gradation of fine aggregates (sand) shall conform to ASTM C-33.
Water shall conform to Section 725.4.

728.3 PROPORTIONING OF MIXTURES AND PRODUCTION TOLERANCES:

Proportioning of the mixture shall comply with Section 725.6 and Table 728-1. The CLSM shall have consistency, workability, plasticity, and flow characteristics such that the material when placed is self-compacting. A minimum of 40% coarse aggregate shall be used. A mix design shall be submitted for the Engineer's approval prior to the excavation for which the material is intended for use. Sampling shall be in accordance with ASTM D-5971. The flow consistency shall be tested in accordance with ASTM D-6103. Unit weight (when applicable) shall be obtained by ASTM D-6023. Compressive strength shall be tested in accordance with ASTM D-4832.

TABLE 728-1	
CONTROLLED LOW STRENGTH MATERIAL REQUIREMENTS	
Portland Cement Content, Sack/cu yd	Flow, inches
1/2 Sack	9±2
1 Sack	9±2
1 1/2 Sack	9±2

Note for Table 728-1:

1) CLSM mixes meeting the table requirements will not generally be placeable by means of a concrete pump or may not provide the needed workability for certain conditions. When pumpable mixes or increased workability are required, the addition of fly ash or a natural pozzolan in excess of the required Portland

DRAFT

TABLE 776-4			
GROUT FOR REINFORCED MASONRY PROPORTIONS BY VOLUME FOR FIELD BATCHING			
Type	**Portland Cement**	**Fine Aggregate (ASTM C-404)**	**Coarse Aggregate (ASTM C-404)**
Fine Grout	1	2 1/4 to 3	0
Coarse Grout	1	2 1/2	1 to 2

776.2 PORTLAND CEMENT:

The cement used shall conform with Section 725. For volumetric proportioning an unopened sack of cement weighing 94 pounds shall be considered as having a 1 cubic foot volume.

In proportioning the cement, it shall be measured loose, without shaking or compacting, in measuring devices of known capacity.

776.3 AGGREGATE: **(Note: Transferred from Sections 701.3.2 and 701.3.4 with modifications)**

~~The~~ All aggregate ~~used shall conform with Section 701. It~~ shall be approved by the Engineer prior to being utilized on the job. ~~Any change of course will require additional approval or this neglect will be considered as sufficient cause for rejection of work.~~

Fine aggregate (sand) to be used in mortar shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances. The size and grading of fine aggregate shall conform to the applicable requirements of ASTM C-144.

Fine or coarse aggregate to be used in masonry grout shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances. The size and grading of fine or coarse aggregate shall conform to the applicable requirements of ASTM C-404.

The average value of sand equivalent determined on 3 successive samples shall not be less than 70. No individual sample shall have a sand equivalent less than 65.

In proportioning the aggregate, it shall be measured damp, loose without shaking or compacting, in measuring devices of known capacity.

776.4 MASONRY CEMENT:

Masonry cement used shall conform to ASTM C-91 with the exception that the average compressive strength shall not be less than 2500 psi at 28 days.

776.5 HYDRATED LIME:

Hydrated lime used shall conform to ASTM C-207, Type S.

776.6 WATER:

The water used shall conform to section 725.

776.7 ADMIXTURES:

Admixtures, unless prescribed in the special provisions, will not be used without prior approval of the Engineer.

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SECTION 206

STRUCTURE EXCAVATION AND BACKFILL

206.1 DESCRIPTION:

Structure excavation shall consist of the removal of material for the construction of foundations for bridges, manholes, retaining walls, box culverts, head walls for culverts, and other structures, and other excavation designated on the plans or in these specifications or in the special provisions as structure excavation.

Structure backfill shall consist of furnishing material, if necessary, and placing and compacting backfill material around structures to the lines designated on the plans or specified or directed by the Engineer.

Structure excavation and structure backfill shall include the furnishing of all materials and equipment and the providing of other facilities which may be necessary to perform the excavations and place and compact the backfill, and the subsequent removal of these facilities, except where they are required or permitted by the plans, special provisions or Engineer to remain in place.

206.2 FOUNDATION MATERIAL TREATMENT:

When footing concrete or masonry is to rest upon rock, the rock shall be fully uncovered and the surface thereof shall be removed to a depth sufficient to expose sound rock. The rock shall be roughly leveled off or cut to approximate horizontal and vertical steps, and shall be roughened. Seams in the rock shall be grouted under pressure or treated as the Engineer may direct and the cost thereof will be paid for as extra work.

When no piles are used and footing concrete or masonry is to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation and final removal of the foundation material to grade shall not be made until just before the concrete or masonry is placed. Excavation below grade shall be replaced with the same class of concrete specified for the structure or with 1 ½ sack controlled low strength material as specified in Section 728. When the replacement material is structural concrete, the material shall be placed at the same time as the structure material. Placement of controlled low strength material shall be per Section 604 which will require a time lag between placement of the material and the structural concrete. The placement of the additional material shall be at no cost to the Agency except when over-excavation is directed by the Engineer.

The excavation for structures shall be completed to the bottom of the footings before any piles are driven therein, and excess material remaining in the excavation after pile driving shall be removed to the elevation of the bottom of the footings.

When piles are used and ground displacement results from pile driving operations, the Contractor shall at his expense excavate or backfill the footing area to the grade of the bottom of the footing as shown on the plans with structure backfill material.

206.3 INSPECTION:

When any structure excavation is completed, the Contractor shall notify the Engineer who will make an inspection of the excavation. No concrete or masonry shall be placed until the excavation has been approved by the Engineer.

206.4 STRUCTURE BACKFILL:

206.4.1 Preparation for Structure Backfill: Prior to the placement of structure backfill, the Contractor shall remove all loose, unstable materials from the sides of the structure excavation that may constitute a safety concern or impact proposed backfill operations. The Contractor shall then compact the bottom of the remaining open structure excavation to a uniform density of not less than 95 percent maximum dry density. With the approval of the compaction of the bottom of the open structure excavation by the Engineer, the Contractor may start the placement of the Structure Backfill.

206.4.2 Structure Backfill for Earth Retaining Structures: Structure Backfill to be placed against concrete structures designed to retain earth loads, such as bridge abutment backwalls and wingwalls, box culvert outside walls and wingwalls, and retaining walls:

(A) Shall conform to the material ~~requirements of Section 701.2.1 Crushed Rock~~, and the gradation requirements for Select Material, Type A or B in Table 702-1 unless otherwise approved by the Engineer.

(B) Shall not be placed until the concrete has reached its full design strength.

(C) Shall be placed in layers not more than 8 inches in depth before compaction, when compacted by pneumatic or mechanical tamping devices.

SECTION 220 – REVISION 8-3-11

RIPRAP CONSTRUCTION

220.1 DESCRIPTION:

Riprap construction shall consist of furnishing and placing stone, with or without grout, and underlain with filter material of granular filter blankets or erosion control geosynthetic fabric. The depth and type of riprap shall be as shown on the plans or in the special provisions.

220.2 MATERIALS

Riprap shall conform to the requirements of Section 703.

Erosion control geosynthetic fabric shall conform to the requirements of Table 796-3 in Section 796.

Waste or sacked concrete shall not be permitted for use as riprap.

The Contractor, at no additional cost, shall provide mechanical equipment, a sorting site, and labor needed to assist in checking riprap gradation.

Granular filter blankets shall consist of processed natural material conforming to the requirements of Section 701~~2.3~~, with the gradation and thicknesses as specified on the plans or in the special provisions.

220.3 PREPARATION OF GROUND SURFACES

The bed for placement of riprap shall be shaped and trimmed to provide even surfaces.

220.4 PLACEMENT OF EROSION CONTROL GEOSYNTHETIC FABRIC:

Fabric shall be placed at the locations shown on the project plans. The Contractor shall provide a surface free of obstructions, depressions, debris, and soft yielding surfaces prior to the placement of fabric. The fabric shall be loosely laid (not in a stretched condition), aligned and placed with no fold over wrinkles.

The fabric shall be placed to provide a minimum 24-inch of overlap for each joint. On horizontal joints, the uphill fabric shall overlap the downhill fabric. On vertical joints, the upstream fabric shall overlap the downstream fabric.

Bedding material shall be placed uniformly on the fabric to the depth specified on the plans and shall be free of mounds, dips, and windrows. Bedding material shall not be compacted.

220.5 RIPRAP PLACEMENT:

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Riprap shall be carefully placed on filter material consisting of a granular filter blanket or the bedding material on erosion control geosynthetic fabric. Placement shall not damage the underlying filter blanket or geosynthetic fabric. If the Engineer determines that the placement of stone has damaged or displaced the filter material to the extent that it cannot function as intended, the Contractor, at his expense, shall remove the placed riprap stone and properly correct the damage to, and/or the displacement of, the filter material. Such correction may include the removal of the filter material, re-grading the affected area, and subsequent replacement of the filter material and riprap stone as required by the Engineer.

Riprap shall be placed in a manner which will produce a dense, reasonably well-graded mass without segregation and with a minimum amount of voids. The larger stone shall be evenly distributed through the riprap mass. The individual placement of larger riprap stones may be required to obtain a uniform distribution of stone size. The riprap placement shall be supplemented by such hand methods as are required to obtain a uniform finished surface. Allowable tolerance from the slope lines and grades shown for the finished riprap surfaces shall not exceed a distance equal to 1/3 of the nominal D_{50} size above or below the design surfaces. The final surface elevations shall be lower than any adjacent apron or pipe invert elevations and shall not obstruct the operation of adjacent structures. The flow line within riprap shall provide positive drainage with minimal ponding. Individual stones shall depress below the finished grades no lower than a distance equal to 1/2 of the nominal D_{50} size. Special care shall be exercised in placing riprap within 3 feet of structures to avoid damage to such structures.

220.6 GROUTED RIPRAP:

Place riprap as specified in Section 220.5, excluding the use of filter material~~, then grout~~ and secure in place with portland cement ~~mortar~~ grout meeting the requirements of Table 220-1. Place grout to the depth as shown on the plan but in no case less than 70 percent of the depth of riprap. Consolidate grout into place with suitable spades, trowels or other approved means to provide a dense stone and mortar layer with all voids and interstices filled. After grout has been placed, the rocks shall be thoroughly brushed so that their top surfaces are exposed. If required, use water pressure to clean stone faces after the mortar has achieved sufficient strength. The outer rocks shall project 1/3 to 1/4 their diameter above the grouted surface.

Table 220-1 Grout for RipRap

Minimum Cementitious Material (lbs)	Maximum W/CM Ratio	Slump (in)	Air Content (%)
850	0.60	9 +/- 2	0 % - 8 %

~~The grout shall consist of 1 part cement and 3 parts by volume of aggregate.~~ The ~~portland cement~~ cementitious materials shall meet the requirements ~~be Type II as specified in~~ of Section 725.2. Up to 25 percent by weight of the Table 220-1 minimum cementitious materials requirements may be an approved fly ash or natural pozzolan. The aggregates shall meet the applicable requirements of ASTM C-33, #8 (3/8") coarse aggregate grading and fine aggregate

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(sand) grading. All Ready Mixed Grout volume calculations shall be based on "absolute volume" with the total volume per cubic yard equal to 27 cubic feet. Coarse aggregate volume shall be a maximum of 35% of the total aggregates volume. ~~shall be 2 parts sand and 1 part gravel passing a 3/8 inch square mesh screen. The quality of the sand and gravel~~ **shall** ~~be as specified in~~ Section ~~701~~. All mixing shall be in accordance with the applicable requirements of Section 725.7.

The amount of ~~water~~ slump shall be the minimum amount needed ~~such as~~ to permit gravity flow into the interstices with limited spading and brooming. The consistency of the grout shall be as approved by the Engineer.

~~Except when hand mixing is permitted by the Engineer, grout shall be mixed in an approved machine mixer for not less than 1 1/2 minutes. Should hand mixing be permitted, the cement and aggregate shall be thoroughly mixed in a clean, tight mortar box until the mixture is of uniform color after which clean water shall be added in such quantity as to provide a grout of the required consistency.~~

220.7 MEASUREMENT:

The completed, in place riprap construction within the limits of the dimensions shown on the plans shall be measured. Measurement will be in cubic yards rounded to the nearest cubic yard.

No separate measurement will be made for erosion control geosynthetic fabric, bedding material, or grout.

220.8 PAYMENT:

Payment for riprap will be made for the accepted complete in-place riprap construction at the contract unit price. Riprap construction shall include excavation, ground surface preparation, erosion control geosynthetic fabric (if used for the project), bedding material, riprap stone, grout (if used for the project) and backfilling.

Payment for riprap shall be full compensation for furnishing all material, labor and equipment for riprap construction.

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SECTION 325

ASPHALT-RUBBER CONCRETE OVERLAY, GAP GRADED

325.1 DESCRIPTION:

Asphalt-rubber concrete consists of supplying, placing and compaction of plant mixed gap graded asphalt-rubber concrete over asphalt surfaces. The thickness of the finished asphalt-rubber concrete overlay shall be within the range of one to two inches as shown on the plans or as specified in the special provisions.

325.2 MATERIALS:

Asphalt-rubber concrete shall consist of a mixture of aggregate and asphalt-rubber binder. Tack coat, asphalt-rubber concrete mix and transportation thereof shall be as specified in Sections 710 and 321, except as modified below:

325.2.1 AGGREGATE:

The aggregate shall meet the following gradation:

Sieve Size	Percent Passing
½ inch	100
3/8 inch	78-92
#4	28-42
#8	15-25
#30	5-15
#200	3-7
*Type II portland cement	1.5%
Or	
*Hydrated Lime	1.0%

***By total weight of the mineral aggregate.**

~~The aggregate shall conform to the requirements of Sections 701 and 710 for asphalt concrete, except as modified below:~~

~~Sand Equivalent~~	~~65% minimum~~
~~Crushed Aggregate retained on #8 sieve (at least one crushed face, produced by crushing)~~	~~85% minimum~~

Characteristics	**Test Method**	**Requirements**
Fractured Faces, % (Plus No. 8)	ARIZ 212	85, 1 or more
Uncompacted Voids, % Volume)	ARIZ 247	45.0 (High Traffic
		42.0 (Low Traffic Volume)
Sand Equivalent (Minus No. 4)	AASHTO T 176	65 minimum
Plasticity Index	AASHTO T89 & T 90	Non Plastic
L.A. Abrasion, % Loss	AASHTO T 96	9 max. @ 100 Rev. 40 max. @ 500 Rev.
Combined Bulk Specific Gravity	AI MS-2	2.35-2.85
Combined Water Absorption, %	AI MS-2	0-2.5

Changes per Case 11-22

SECTION 333

FOG SEAL COATS

333.1 DESCRIPTION:

Fog seal coats on bituminous paved surfaces shall consist of the application of emulsified asphalt and a sand blotter when necessary.

333.2 TIME OF APPLICATION AND WEATHER CONDITIONS:

Fog seal coats on new pavements shall be applied within 24 hours. This time restriction may be extended by the Engineer.

Emulsified asphalt shall not be applied when the surface is wet or when there is a threat of rain. The ambient temperature shall be at least 50 degrees F. and rising and the application shall cease when the temperature is 55 degrees F. and falling.

333.3 MATERIALS:

333.3.1 Emulsified Asphalt: Unless otherwise specified in the special provisions, emulsified asphalt may be a grade SS-1h, CSS-1h, or CQSH, as specified in Section 713. The emulsified asphalt shall be diluted in proportions of 50% water and 50% emulsified asphalt.

333.3.2 Sand Blotter: The sand shall be as specified in Section ~~701~~ 701.3 and shall be graded in accordance with Table 333-1.

TABLE 333-1	
SAND BLOTTER GRADATION	
Sieve Size	**Percentage Passing (by weight)**
3/8 inch	100%
No. 4	90-100%
No. 200	0-12%

333.4 TESTS, TEST REPORTS AND CERTIFICATIONS:

Asphalt emulsion shall meet requirements of Section 713.

Test reports and certifications shall be as specified in Section 711.

333.5 PREPARATION OF SURFACES:

Immediately before applying the emulsion, the area to be surfaced shall be cleaned of dirt and loose material by means of power brooms, or pick-up brooms supplemented by hand brooms if necessary. The fog seal shall not be applied until an inspection of the surfaces has been made by the Engineer and he has determined that the surfaces are suitable.

333.6 APPLICATION OF ASPHALT EMULSION:

The diluted material shall be well mixed before application. It shall be applied by a distributor truck equipped with fog nozzles at the approximate rate of 0.10 gallon per square yard. The exact rate shall be as directed by the Engineer. The distributor truck shall be as specified in Section 330.

For large-diameter pipe installations where the backfill material is other than coarse aggregate, consolidation shall be by mechanical means. Water consolidation may be used as a compaction method for the backfill material only when prior written approval to do so is provided by the Engineer.

tested in accordance with ARIZ 212

603.4.6 Specifications for Material: Coarse aggregate shall consist of crushed rock as defined in Section ~~701~~ 701.2 with 100 percent of the specified size of aggregate having one fractured face, and having the gradation complying with ASTM D-448, Table 1, Size Numbers 6, 67, 68, 7, 78, or 8 as recommended by the Engineer. The gradation size number to be furnished shall be shown on the plans or in the project specifications.

603.4.7 Rights-of-Way Belonging to Others: Rights-of-way belonging to others shall comply with Subsection 601.4.7.

603.4.8 Test Holes: Test holes shall comply with Subsection 601.4.8.

603.4.9 Foundation and Bedding for Electronic, Telephonic, Telegraphic, Electric, Oil and Gas Lines: Foundation and bedding for electronic, telephonic, telegraphic, electric, oil and gas lines shall comply with Subsection 601.4.9.

603.5 PREPARING AND INSTALLING HDPE PIPE:

603.5.1 Storage and Handling: Pipe shall be stored and handled in such a way to minimize out-of-roundness. Pipe shall be stored in shaded areas to minimize adverse effects of thermal, and ultraviolet exposure.

Pipe that is out-of-round in excess of 3% of the nominal pipe diameter as specified in Section 738, shall not be installed and shall be removed if installed.

603.5.2 Strutting: Strutting of Profile HDPE pipe per Section 738 will be required when the diameter is 42 inches or larger. For Profile HDPE pipe with diameters smaller than 42 inches, strutting may be required at the discretion of the Engineer. Strutting of Corrugated HDPE pipe per Section 738 is not required.

Strutting consists of placing wood struts, whose length is typically 3% longer than the nominal pipe diameter, inside the pipe. A minimum of three (3) sets of struts are placed in each pipe length, oriented vertically, spaced equally throughout the length of pipe and set so as not to interfere with the jointing of the pipe. The struts shall be kept in place until the bedding material is placed and compacted around the pipe. The struts must be removed before any backfill or bedding is placed above the pipe. The procedure of strutting the pipe shall not damage the pipe in any way. If the pipe is out of round, the struts will be placed in the long direction of the out-of-round. If the strut cannot be held in place by the pipe, the pipe will be removed from the job site per Subsection 738.9.

603.5.3 Orienting: If the pipe is out-of-round, the pipe should be oriented so that the long axis is placed vertically when installed in the trench. When struts are used, the struts shall be oriented vertically when pipe is installed in the trench.

603.5.4 Installing Pipe: HDPE pipe and fittings shall be installed in accordance with ASTM D-2321 or manufacturer's recommendation. HDPE pipe shall be handled so as not to damage the pipe. Hoisting shall be accomplished with cloth belt slings or ropes. The pipe shall be protected by wood blocking when jointing is accomplished by pipe jacking, back hoe bucket, come-along, or cable pipe puller.

603.6 PAVEMENT REPLACEMENT AND SURFACE RESTORATION:

Pavement replacement and surface restoration shall comply with Subsection 601.5.

603.7 PAYMENT:

No pay item will be included in the proposal, nor direct payment made for trench excavation, backfilling, compaction, or placement of temporary pavement. The cost of these features of work shall be included in the unit price per bid per linear foot for furnishing and laying pipe.

End of Section

604.4 PROTECTION:

When CLSM is placed within the traveled way or otherwise to be covered by paving or embankment materials, the material shall achieve a penetration resistance of 3 inches (indentation diameter) or less with 5 drops at a drop distance of 5 inches prior to covering and opening to traffic or the installation of the surface be delayed for 12 hours, which ever occurs first. Penetration resistance shall be as measured by ASTM Test Method D-6024, "Standard Test Method for Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application."

When CLSM is placed in foundation excavations, the material shall be protected from foundation loading and placement of foundation concrete prior to having reached initial set per ASTM C-403, or allowed to set in place for 24 hours, whichever occurs first.

Where the Engineer has identified soils as being moisture sensitive, a drainage notch or drain wick shall be placed longitudinally along the centerline of the trench or CLSM placement. The notch or wick shall be constructed within the first hour following placement. Drainage water shall be collected and removed at the end of notch or wick.

604.5 ACCEPTANCE:

CLSM shall be considered deficient and may be rejected at the discretion of the Engineer if:

(A) The CLSM is outside of the limits specified in Table 728-1 and/or

(B) The aggregate gradation is outside the limits specified in Section ~~701.3.5.~~ 728.2

Rejected material not placed shall be immediately removed from the job site. Rejected material placed shall be removed and replaced with acceptable material. Removing and disposing of the rejected material shall be at no additional cost to the Contracting Agency.

604.6 PAYMENT:

No pay item will be included in the proposal nor direct payment made for CLSM. The cost for placing the material shall be included in the unit price bid for the specific work function (laying pipe, placing structure foundation, construction retaining wall, etc.).

End of Section

SECTION 605

SUBDRAINAGE

605.1 DESCRIPTION:

The subdrainage system shall be constructed in accordance with the notes and details shown on the plans and the applicable provisions of these specifications except as modified in the special provisions.

605.2 CONCRETE:

All concrete placed in drainage structures, subdrain outlets, pipe collars, and similar features of the subdrainage system shall conform to the applicable provisions of Section 725.

605.3 SUBDRAINAGE PIPE:

Subdrainage pipe, both perforated and non-perforated, shall be either bell and spigot concrete, bell and spigot vitrified clay, corrugated metal pipe, or asbestos-cement pipe as shown on the plans or specified in the special provisions. However, if the particular kind of pipe is not shown on the plans nor specified in the special provisions, subdrainage pipe shall be concrete pipe of at least standard strength quality and shall conform to the requirements of Section 736. Vitrified clay pipe shall conform to the requirements of Section 743. Asbestos-cement pipe shall conform to the requirements of Section 737. Corrugated metal pipe shall conform to the requirements of Section 760.

605.3.1 Pipe Joints: Unless the pipe joints are of a self-aligning type, have the bottom half of the bell joint filled with mortar to securely hold the pipe in alignment and to bring the inner surface of abutting pipes flush and even. Where a tight joint for non-perforated pipe is required, the bell joint shall be completely filled with mortar.

Asbestos-cement pipe joints shall be made with couplings in accordance with the recommendations of the pipe manufacturer.

605.4 SUBDRAINAGE MANHOLES:

Subdrainage manholes, including inlets, outlets, flap gates, gate boxes, and drop steps, shall comply with the requirements of the plans and the special provisions.

605.5 FILTER MATERIALS:

The filter materials shall be placed within the limits shown on the plans. The compositions of the filter materials shall each conform to one of the grading requirements in Table 605-1; the particular requirement to be used will be specified in the special provision.

The materials used shall conform to requirements for concrete aggregates in Section ~~701~~ 725.3; however, the requirements for grading, and reactivity, as stated therein, shall not apply. The minimum bulk specific gravity shall be 2.50, by ASTM C-127.

TABLE 605-1

FILTER MATERIAL GRADING - % PASSING

Screen or Sieve Size	TYPE		
	F1	F2	F3
3/4″		100	100
3/8″	100	80 - 100	70 - 100
No. 4	90 - 100	60 - 85	45 - 75
No. 8	75 - 90	45 - 70	30 - 60
No. 16	55 - 80	30 - 55	20 - 45
No. 30	30 - 60	15 - 40	10 - 30
No. 50	10 - 40	5 - 20	0 - 15
No. 100	0 - 15	0 - 10	0 - 5
No. 200	0 - 5	0 - 5	

SECTION 620

CAST-IN-PLACE CONCRETE PIPE

620.1 GENERAL:

This specification covers cast-in-place non-reinforced concrete pipe intended for use as storm sewers or irrigation lines. The abbreviated title is CIPP. CIPP is conduit made of portland cement concrete cast monolithically in a properly prepared trench, using equipment specifically designed for this purpose. The type of equipment to be used by the Contractor must be approved by the Engineer and the Contractor may be required to furnish evidence of the successful use of this equipment on prior work. CIPP will be placed only:

(A) By experienced operators. The Engineer will be the sole judge as to experience level.

(B) In the presence of the Engineer.

(C) In ground capable of standing unsupported from the bottom of the trench to the top of the pipe without sloughing.

(D) In fill when it can be demonstrated to the satisfaction of the Engineer that the fill will adequately support the pipe.

620.2 MATERIALS:

620.2.1 Cement shall be ASTM C-150, Type II, low alkali as per Section 725.

620.2.2 Sand aggregate used for concrete and mortar shall conform to Section ~~701~~ 725.3. Maximum size of the aggregate shall not be greater than ⅓ of the minimum wall thickness up to and including a wall thickness of 4 ½ inches. The maximum aggregate size is 1 ½ inches.

620.2.3 Water used for concrete and for curing the pipe shall be as per Section 725.

620.2.4 Concrete shall be Class A in accordance with Section 725. Slump shall be the minimum required for satisfactory placement of the concrete by the equipment used by the Contractor. The slump shall not exceed 3 inches.

620.2.5 Bonding mortar shall consist of two (2) or more parts of cement to three (3) parts of sand by volume.

620.3 CONSTRUCTION METHODS:

620.3.1 Excavation: The trench will be neatly excavated with vertical sides and semi-circular bottom. The trench shall be shaped to form the bottom outside of the pipe on the alignment and to the grades specified in the plans. Departure from and return to established grade shall not exceed 1 inch per 10 linear feet with a maximum allowable departure of 1 ½ inches. Departure from and return to specified alignment shall not exceed 2 inches per 10 linear feet with a maximum allowable alignment departure of 4 inches. The bottom of the trench, hereinafter known as the trench form, will be shaped to provide full, firm, and uniform support by undisturbed earth or compacted fill for at least the bottom 210 degrees of the pipe. Density of the fill shall be at least five percent (5%) greater than the natural inplace soil, but in no case less than 85 percent (85%) when tested in accordance with AASHTO T-99, Method A and T-191 or ASTM D-2922 and D-3017.

When it is necessary to install the pipe in rocky areas, the rock will be removed and replaced with suitable fill material compacted to proper density. The rock will be over-excavated to leave a 6 inches minimum compacted soil cushion between the rock and the pipe. For construction accuracy, areas left void by rock removal will be completely filled with compacted material, then trenched for the pipe as though natural ground. If the rock below the pipe subgrade is fractured or fragmented or if it consists of large cobblestones or boulders, the replacement fill material will be carefully selected to insure that it is of such gradation that it will not be removed downward by fluctuation of the water table. In no case will expansive soils be used for fill. A similar procedure of over-excavation, backfill, compaction, and retrenching will be used where sloughing sand or where soft or spongy soil conditions are encountered. When expansive clays are encountered, they will be thoroughly moistened by ponding, to completely expand the soil, and the moisture maintained until the concrete is placed.

Where the pipe is to be constructed through fill materials, such fill shall have stability in the zone of the trench form equal to firm undisturbed earth, in the area adjacent to the fill.

SECTION 714

MICROSURFACING MATERIALS

714.1 GENERAL:

Microsurfacing materials shall consist of a properly proportioned mixture of cationic polymer modified asphalt emulsion, mineral aggregates, mineral filler, water, and other additives.

714.2 AGGREGATE:

714.2.1 Mineral Filler: Mineral filler, as required by the mix design, shall be any recognized brand of non-air-entrained Type I/II normal Portland cement that is free of lumps and clods, with a minimum of 85% passing the #200 sieve, added by weight of aggregate as specified by the mix design.

Coarse and fine aggregates or approved mineral filler shall be per Section 701.

714.2.2 Mineral Aggregate: ~~Mineral aggregate shall consist of sound, durable crushed stone or crushed gravel, per Section 701, and approved mineral filler. The material shall be free from vegetable matter and other deleterious substances.~~ Aggregates shall be 100% crushed with no rounded particles. No natural sand will be allowed. The mineral aggregate shall conform to Table 715-1 for gradation only. Application rates shall be 18-24 pounds of aggregate/square yard for Type II, and 24-35 pounds/square yard for Type III.

The mineral aggregate and mineral filler shall have a sand equivalency value not less than 50 (ASTM D 2419) and be non-plastic.

If more than one kind of aggregate is used, the correct amount of each kind of aggregate needed to produce the required gradation shall be proportioned separately in a manner that will result in a uniform and homogeneous blend. The final blended aggregate shall meet the above requirements for grading, sand equivalency, and plasticity.

714.3 BITUMINOUS MATERIAL:

The Polymerized Emulsion is a slow-setting, cationic type emulsion for mixing applications and seal coats. A minimum of 4% saturated polymer shall be high sheared into the asphalt prior to the emulsification process. The Agency may choose to sample the polymerized asphalt for testing. The amount of polymer will be based on weight of polymer and asphalt (total weight) and be certified by the supplier. The polymerized emulsion will meet the following specifications listed in Table 714-1.

SECTION 715

SLURRY SEAL MATERIALS

715.1 GENERAL:

Slurry seal shall consist of a properly proportioned mixture of emulsified asphalt, mineral aggregate, mineral fillers, and water.

All material source must be approved prior to their use. The Contractor will submit material samples at least seven days prior to start of construction. When requested, additional samples will be furnished during the construction period at no cost to the Contracting Agency. This is a non-pay item.

715.2 AGGREGATE:

715.2.1 Mineral Filler: Mineral filler shall consist of finely divided matter, such as hydrated lime, portland cement, limestone dust or fly ash, conforming to the requirements of ASTM D-4318. Mineral filler shall be used only when needed to reduce the setting time, to improve the workability or to reduce the stripping characteristics of the aggregate emulsion mixture. The minimum amount of the required filler will be used and it will be considered as part of the blended aggregate. The expected range shall be between .25% and 2.0% by weight of aggregate.

Coarse and fine aggregates or approved mineral filler shall be per Section 701.

715.2.2 Mineral Aggregate: ~~Mineral aggregate shall consist of sound and durable sand and/or crushed stone as per MAG Section 701 combined with an approved mineral filler where it is required~~. The mineral filler will be considered as part of the blended aggregate. The material shall be non-plastic (ASTM D-4318) with a sand equivalent (ASTM D-2419) of at least 50. The abrasion loss (ASTM C-131) shall not exceed 35 percent. Ninety percent of the aggregate retained on the No. 50 sieve shall have at least one fractured face. The gradation of material aggregate shall conform to Table 715-1.

715.3 BITUMINOUS MATERIAL:

The emulsified asphalt used for seal coating shall be quick setting or slow setting as per Section 713.

The quick setting emulsified asphalt shall be of the anionic or cationic quick set type such as QSH or CQSH that will react to chemically active mineral fillers such as portland cement in such a way that the applied slurry mixture can support controlled traffic in 45-60 minutes after application. The amount of chemically active filler shall be determined by mix design and field performance.

Quick Set Emulsion Mix Properties

Slurry Seal Mixing, 70-85 degree F., Sec.	120 Sec. Min.
Slurry Seal Setting text, 70-85 degree F., 1 hour cure	No Brown Stain
Slurry Seal Water Resistance Test, 70-85 degree F., 30 minute cure	No More Than Slight Discoloration

Slow setting emulsion may be used when traffic control is not a critical item.

Placement of slurry seal is temperature dependent and should be tested under field conditions.

715.4 WATER:

Water shall be potable and be compatible with the slurry ingredients used.

715.5 TEST CERTIFICATES & REPORTS:

Test certificates and reports for the bituminous material shall be furnished in accordance with Section 711.

715.6 CONVERSION OF QUANTITIES:

Volumetric conversions shall be accomplished in accordance with Section 713.

SECTION 716

COVER MATERIAL

716.1 GENERAL:

Cover material "chips" shall consist of precoated or uncoated aggregate spread in conjunction with a bituminous or asphalt-rubber seal coat.

716.2 STONE CHIPS:

716.2.1 General: The stone chips shall be ~~crushed rock as~~ coarse aggregate per Section 701 except as modified below.

716.2.2 Tests: The chips' weight loss shall not exceed 40 percent of 500 revolutions where tested in accordance with ASTM C-131.

The chips shall not show a loss in excess of 12 percent when tested in accordance with AASHTO T-104 (Sodium Sulfate Soundness)

A minimum of 75 percent of the material, by weight, retained on the No. 8 sieve, shall have at least one fractured face produced by the crushing operation. when tested in accordance with ARIZ 212.

716.2.3 Gradation: When tested in accordance with ASTM C-136 and C-117, gradation shall comply with Table 716-1 and/or Table 716-2.

TABLE 716-1	
COVER MATERIAL (CHIPS) GRADATION For Low Volume Traffic Only	
Sieve Size	Percent Passing
½ inch	100
3/8 inch	97/100
1/4 inch	70/100
#8	0-5
#200	0-2

Table 716-2	
COVER MATERIAL (CHIPS) GRADATION For High Volume Traffic	
Sieve Size	Percent Passing
3/4 inch	100
½ inch	97/100
3/8 inch	70/100
1/4 inch	0-10
#8	0-5
#200	0-2

SECTION 736

NON-REINFORCED CONCRETE PIPE

736.1 GENERAL:

The size and classes of the non-reinforced concrete pipe to be furnished shall be as shown on the plans, or as specified under the item of work for the project of which the concrete pipe is a part.

Strength classes of non-reinforced concrete shall be as identified in ASTM C-14, Class 1 non-reinforced concrete pipe. Class 2 non-reinforced concrete pipe, or Class 3 non-reinforced concrete pipe.

Unless otherwise specified, Class 3 non-reinforced concrete pipe will be used.

736.2 MATERIALS:

Materials used in manufacturing the pipe shall be as specified in ASTM C-14, with the following exception:

Cement shall conform to ASTM C-150, Type II, low alkali. Samples and testing shall conform to the methods designated therein. The pipe manufacturer shall supply a cement mill certificate, in triplicate, for each load of cement delivered, showing the specification, type, chemical analysis, and quantity. On stockpiled pipe in lieu of the above, the manufacturer shall certify that the type of cement used meets this specification. Satisfactory facilities shall be provided for identifying, inspecting, and sampling cement at the mill, the warehouse, and the site of the work. The Contracting Agency shall have the right to inspect the cement and obtain samples for testing at any of these points. The cement shall be stored in a weathertight, dry, well ventilated structure approved by the Engineer. Cement salvaged by cleaning cement sacks, mechanically or otherwise, shall not be used in the work. Cement containing lumps will be rejected and shall immediately be removed from the site of the work. If the temperature of the cement exceeds 150˚F., it shall be stored until cooled to that temperature.

736.3 PIPE JOINTS:

The joints may be tongue and groove mortared joints, or similar to R-4 or modified R-4 Bureau of Reclamation Through-Bell type joints using O-ring rubber gaskets. With rubber gasket joints, inside mortaring and outside grouting is not required. Tongue and groove joints shall be mortared inside and grouted outside. Grouting of outside joints shall be by the diapering method.

736.3.1 Cement Mortar Joints:

(A) The mortar or grout shall consist of 1 part portland cement and 2 parts sand, by volume. The quantity of water in the mixture shall be sufficient to produce a soft workable mortar, but shall in no case exceed a water-cement weight ratio of 0.53. Where outside joints are made by the diaper method, the grout shall be composed of 1 part cement to 3 parts sand, and shall be mixed to the consistency of thick cream. The sand shall conform to Section ~~701,~~ 776.3 and the cement shall conform to Section 725.

(B) The pipe ends shall be thoroughly cleaned and wetted with water before the mortar or grout is placed. No backfilling around the joints shall be done until the joints have been fully inspected and approved.

(C) Mortar joints shall be cured by keeping them wet for 3 days or by using a curing compound.

736.3.2 Rubber Gasket Joints: Rubber gaskets shall comply with Section 765.

736.4 CURVES, BENDS AND CLOSURES:

Horizontal and vertical long-radius curves shall be formed by slight deflection at the joints, provided that the maximum joint opening caused by such deflection shall not exceed 3/4 inch. Short radius curves shall be formed by straight pipe in which the joints are beveled. The bevel of the pipe shall not exceed 5 degrees, and the total angular deflection for beveled pipe shall not exceed 10 degrees at any joint.

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Case 11-30

DATE: August 17, 2011

TO: MAG Specifications and Details Committee Members

FROM: Peter Kandaris, SRP Representative

RE: **Revisions to Section 702 – Base Materials**

Purpose: Update standard identified by Outside ROW WG

Revisions: The purpose of the changes is to simplify base material requirements with physical properties shown in a single table. Delete information that is redundant to Section 701 (re-defining general aggregate requirements) and remove language that is vague and cannot be enforced through objective tests.

Major changes are summarized below:

(a) Delete references to specific aggregate materials such as decomposed granite, slag, etc., as these should be covered by Section 701 requirements.

(b) Add functional descriptions for ABC and Select Material.

(c) Consolidate all material requirements into Table 702-1. This includes PI, fractured face and LA abrasion testing.

(d) Fractured face for ABC was changed from 50% to 30% to match ADOT requirements.

(e) Change from 1-1/4" sieve to 1" sieve in Table 702-1 as plants do not have the capability to separate at 1-1/4". Modify the gradation requirement for the 1" sieve to meet the same gradation as before.

(f) Include a referee test for aggregates that exceed a PI of 5. A white paper was prepared by the Materials Working Group to give the rational for using an R-value of 70 if the PI is too high (to be provided to the committee at the next meeting).

SECTION 702 – REVISED 8/7/11

BASE MATERIALS

702.1 GENERAL:

Base materials shall be as defined in Section 701, consisting of appropriately sized coarse and fine aggregates, other inert materials, and/or aggregates that have been treated for plasticity index mitigation, as approved by the Engineer.

When base material without further qualification is specified, the Contractor shall supply Aggregate Base Course as defined in Table 702-1. When a particular classification of base material is specified, the Contractor may substitute any higher classification of base material for the specified classification.

The Contractor shall ~~notify~~ provide the Engineer, in writing, material information and the source location at least 10 days prior to use of the material unless the material is currently accept~~able~~ed for use, as determined by the Engineer.

702.1.1 Aggregate Base Course shall be used primarily in roadway applications or where otherwise specified by project special provisions.

702.1.2 Select Material shall be primarily used, but not limited to applicable structure and pipe backfill installations, shoulders, turnouts, driveways, and tapers or where otherwise specified by project special provisions.

702.2 PHYSICAL PROPERTIES:

702.2.1 Base material shall meet the physical properties listed in Table 702-1.

Table 702-1~~2~~			
Sieve Analysis Test Methods AASHTO T-27, T-11			
Sieve Size	Accumulative Percentage Passing Sieve, by Weight		
	Select Material		Aggregate Base Course
	Type A	Type B	
3 in.	100	- -	- -
1-1/2 in.	- -	100	100
1 in.	- -	- -	90 – 100
No. 4	30 - 75	30 - 70	38 - 65
No. 8	20 - 60	20 - 60	25 – 60
No. 30	10 - 40	10 - 40	10 – 40
No. 200	0 - 12	0 - 12	3 – 12
Plasticity Index Test Methods AASHTO T-89 Method A, T-90, T146 Method A			
Maximum allowable value	5	5	5
Fractured Face, One Face Test Method ARIZ 212, ~~One Face~~Percent by Weight of the Material Retained on a #4 Sieve			
Minimum required value	30	30	30
Resistance to Degradation and Abrasion by the Los Angeles Abrasion Machine Test Method AASHTO T-96, Percent Loss by Weight			
Maximum allowable value at 100 revolutions	10	10	10
Maximum allowable value at 500 revolutions	40	40	40

702.2.2: Base material that does not meet Table 702-1 properties may be approved at the Engineer's discretion if the R-Value is at least 70 when determined by test method AASHTO T-190.

End of Section

SECTION 702

BASE MATERIALS

702.1 GENERAL:

Base materials shall be as defined in Section 701, consisting of appropriately sized coarse and fine aggregates, other inert materials, and/or aggregates that have been treated for plasticity index mitigation, as approved by the Engineer.

~~Materials for use as aggregate base shall be classified in the order of preference as follows~~:

~~(A) Crushed Aggregate.~~

~~(B) Processed Natural Material.~~

~~(C) Processed Steel Slag.~~

~~(D) Decomposed Granite.~~

Delete. Materials to be used for aggregates are classified in Section 701. Include specific aggregate base limitations and allow for PI stabilized base material.

Aggregate Base Course as defined in Table 702-1

When base material without further qualification is specified, the Contractor shall supply ~~crushed aggregate~~. When a particular classification of base material is specified, the Contractor may substitute any higher classification of base material for the specified classification.

"crushed aggregate" is not a defined material. Use ABC as it is a defined product.

Simplify language. No justification is needed for requiring advanced notification.

~~Except where materials are being obtained from a previously approved source, the~~ The Contractor shall ~~give~~ provide the Engineer ~~advance notice, in writing, of the source~~ material information and the source location, in writing, at least 10 days prior to use of the base material ~~he intends to use in order to allow sufficient time to perform the necessary tests.~~ unless the material is currently accepted for use, as determined by the Engineer.

702.1.1 Aggregate Base Course shall be used primarily in roadway applications or where otherwise specified by project special provisions.

702.1.2 Select Material shall be primarily used, but not limited to, applicable structure and pipe backfill installations, shoulder, turnouts, driveways, and tapers, or where otherwise specified by the project special provisions.

702.2 ~~CRUSHED AGGREGATE~~: PHYSICAL PROPERTIES:

~~Crushed aggregate shall consist of crushed rock or crushed gravel or a combination thereof as defined in Section 701.~~ **Delete, redundant.**

~~**702.2.1 Soundness:** The percentage of wear of crushed aggregate to be used as base will be determined as in Section 701, except that Grading B of ASTM C-131 shall be used. The percentage of wear of the material shall not exceed 40 after 500 revolutions.~~

~~**702.2.2. Grading:** The aggregate shall be well graded when tested in accordance with ASTM C-136 and C-117. The percentage composition by weight shall be within Table 702-1.~~

Simplify. Put test methods in Table 702-1.

~~Table 702-1~~

~~CRUSHED AGGREGATE GRADATION~~

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve		
	Select Material		Aggregate Base
	Type A	Type B	
3"	100		
11/2"		100	
11/4"			100
No. 4	30-75	30-70	38-65
No. 8	20-60	20-60	25-60
No. 30	10-40	10-40	10-40
No. 200	0-12	0-12	3-12

~~**702.2.3 Plasticity Index.** Unless otherwise noted, the Plasticity Index as tested in accordance with AASHTO T-146 Method A (Wet Preparation), T-89 and T-90 shall not be more than 5.~~

Place all material grade, PI, fractured face, and abrasion with test requirements in a single table.

702.2.1 Base material shall meet the physical properties listed in Table 702-1.

Table 702-1			
Sieve Analysis Test Methods AASHTO T-27, T-11			
Sieve Size	Accumulative Percentage Passing Sieve, by Weight		
	Select Material		Aggregate Base Course
	Type A	Type B	
3 in.	100	- -	- -
1-1/2 in.	- -	100	100
1 in.	- -	- -	90 – 100
No. 4	30 - 75	30 - 70	38 - 65
No. 8	20 - 60	20 - 60	25 – 60
No. 30	10 - 40	10 - 40	10 – 40
No. 200	0 - 12	0 - 12	3 – 12
Plasticity Index Test Methods AASHTO T-89 Method A, T-90, T146 Method A			
Maximum allowable value	5	5	5
Fractured Face, One Face Test Method ARIZ 212, Percent by Weight of Material Retained on #4 Sieve			
Minimum required value	~~50~~ 30	~~50~~ 30	~~50~~ 30
Resistance to Degradation and Abrasion by the Los Angeles Abrasion Machine Test Method AASHTO T-96, Percent Loss by Weight			
Maximum allowable value at 100 revolutions	10	10	10
Maximum allowable value at 500 revolutions	40	40	40

From 701.2

702.2.2: Base material that does not meet Table 702-1 properties may be approved at the Engineer's discretion if the R-Value is at least 70 when determined by test method AASHTO T-190.

Use the R-value as a referee test if PI is out. See the Working Group white paper analysis.
The fractured face count is indirectly referenced in 701.2.1 as 50. Use ARIZ 212 & change to 30 to match ADOT requirements.
Sieve changed from 1-1/4" to 1" since plants do not have the ability to grade at 1-1/4 inches. Gradation adjusted for smaller sieve.

SECTION 702

~~**702.3 PROCESSED NATURAL MATERIAL:**~~

~~**702.3.1 General:** Processed natural material shall consist of hard, durable fragments of stone or gravel and a filler of sand or other finely divided mineral matter. It shall be free from an excess of soft or disintegrated pieces, alkali, adobe, vegetable matter, loam, or other deleterious substances.~~

Delete. Covered in Section 701.

~~**702.3.2 Physical Requirements:** When sampled and tested in accordance with standard test methods, the aggregate shall meet the following requirements:~~

~~(A) Percentage of Wear: When tested in accordance with ASTM C-131, the percentage of wear shall not exceed 40 percent after 500 revolutions.~~

~~(B) Plasticity Index: When tested in accordance with AASHTO T-146 Method A (Wet Preparation), T-89 and T-90, the plasticity index shall not be more than 5.~~

Move into Table 702-1

~~(C Liquid Limit: When tested in accordance with AASHTO T-89, the liquid limit shall not be more than 25 percent.~~

Deleted. Not realistic with PI limit of 5.

~~**702.3.3 Crushed Material:** Crushed material is not required, but may be incorporated in the finished product.~~

Meaningless – includes no enforceable standard.

~~**702.3.4 Grading:** The aggregate shall conform to the sieve analysis in this specification except that the least dimension of the maximum particle size shall not exceed 2/3 of the compacted thickness of the specified lift being placed.~~

This is a placement, not a material requirement. Table 702-1 does not provide for changing max particle size for various lift thickness.

~~**702.4 DECOMPOSED GRANITE:**~~

~~Decomposed granite shall be any granitoid igneous rock which has been weathered in place and which has as principal constituents granular fragments of quartz and feldspar. It may also contain fragments of granitic rock not yet broken down into the component minerals. This material shall remain stable when saturated with water. Particles larger than 3 inches, which will not be broken in the process of rolling and tamping during construction, shall not be used.~~

Meaningless – "stable when saturated with water" and "broken down during the process of rolling and tamping" are subjective.
Use LA abrasion testing as a measureable testing method in lieu of subjective requirements.

~~Decomposed granite shall conform to the following requirements:~~

~~(A) When tested in accordance with this specification, not more than 20 percent shall pass the No. 200 mesh sieve.~~

~~(B) The P.I. of material passing the No. 200 sieve prior to testing shall not be less than 3 nor greater than 10. The Plasticity Index shall be tested in accordance with AASHTO T-146 Method A (Wet Preparation), T-89 and T-90.~~

Contradicts Table 702-1 requirements. Delete

~~**702.4.1 Preparation of Test Specimens:** A quantity of sufficient size to have a dry weight of 15 pounds shall be selected and dried to constant weight at a temperature between 215°F. and 230°F. Fifteen pounds of this material shall then be subjected to 500 revolutions in a Los Angeles abrasion machine, as described in Section 701, except that nothing shall be placed in the drum other than the material to be tested.~~

~~The material that has been subjected to the breakdown shall be tested in accordance with ASTM C-117 to determine the percentage of material finer than a No. 200 mesh sieve by washing.~~

Covered by the test requirements in Table 702-1.

End of Section

Case 11-30

DATE: July 13, 2011

TO: MAG Specification and Details Committee Members

FROM: Brian Gallimore, Materials Working Group/AGC

RE: Section 702 – Base Material

PURPOSE: Moved all ABC material to 310 section

REVISIONS: a) Removed AB order of preference

SECTION 702

BASE MATERIALS

702.1 GENERAL:

~~Materials for use as aggregate base shall be classified in the order of preference as follows:~~ Base materials shall consist of appropriately sized aggregate as defined in section 701, or other approved inert materials of similar characteristics, including recycled material, and materials that have been treated for plasticity index mitigation. Base materials shall be clean and free from vegetable matter and other deleterious substances. The Contractor shall notify the Engineer, in writing, at least 10 days prior to use of the material unless the material is currently acceptable for use as determined by the Engineer.

~~(A) Crushed Aggregate.~~

~~(B) Processed Natural Material.~~

~~(C) Processed Steel Slag.~~

~~(D) Decomposed Granite.~~

~~When base material without further qualification is specified, the Contractor shall supply crushed aggregate. When a particular classification of base material is specified, the Contractor may substitute any higher classification of base material for the specified classification.~~

702.1.1 Aggregate base course ~~material~~ shall be used primarily in roadway applications ~~except~~ or where otherwise specified by project special provisions. ~~Aggregate base shall conform to the requirements listed below.~~

702.1.2 Select material shall be primarily used, but not limited to applicable structure and pipe backfill installations, shoulders, turnouts, driveways, and tapers or where otherwise specified by project special provisions. ~~Select material shall meet the requirements listed below.~~

~~Except where base materials are being obtained from a previously approved source, the Contractor shall give the Engineer 10 days advance notice, in writing, of the source of the base material he intends to use in order to allow sufficient time to perform the necessary tests.~~

~~702.2 CRUSHED AGGREGATE~~PHYSICAL PROPERTIES~~:~~

~~Crushed aggregate shall consist of crushed rock or crushed gravel or a combination thereof as defined in Section 701.~~

~~**702.2.1 Soundness**~~**Abrasion:** ~~The percentage of wear of crushed aggregate to be used as base will be determined as in Section 701, except that~~using ~~Grading B of ASTM C-131,~~ grading B ~~shall be used. The percentage of wear of the material shall not exceed 40 after 500 revolutions.~~

Comment [DR6]: Included in table?

~~702.2.2 **Angularity:** The amount of coarse aggregate particles retained n the No. 4 sieve shall be a minimum of 50% as determined in accordance with test method Ariz 212.~~

Comment [DR7]: Included in table?

702.2.2.13. Grading: The aggregate base material shall be well graded when tested in accordance with ASTM C-136 and C-117. The percentage composition by weight shall be within Table 702-1. meet the physical properties listed in Table 702-2.

Table 702-12			
Sieve Analysis Test Methods AASHTO T-27, T-11			
Sieve Size	Accumulative Percentage Passing Sieve, by Weight		
	Select Material		Aggregate Base Course
	Type A	Type B	
3 in.	100	- -	- -
1-1/2 in.	- -	100	100
1 in.	- -	- -	90 – 100
No. 4	30 - 75	30 - 70	38 - 65
No. 8	20 - 60	20 - 60	25 – 60
No. 30	10 - 40	10 - 40	10 – 40
No. 200	0 - 12	0 - 12	3 – 12
Plasticity Index Test Methods AASHTO T-89 Method A, T-90, T146 Method A			
Maximum allowable value	5	5	5
Fractured Face Test Method ARIZ 212, One Face			
Minimum required value	30	30	3050
Resistance to Degradation Test Method AASHTO T-96			
Maximum allowable value at 100 revolutions	10	10	10
Maximum allowable value at 500 revolutions	40	40	40

Table 702-1

CRUSHED AGGREGATE GRADATION

Percentage by Weight Passing Sieve

Sieve Sizes (Square Openings)	Select Material		Aggregate Base
	Type A	Type B	
3"	100		
1 ½"		100	
1 ¼"			100
No. 4	30-75	30-70	38-65
No. 8	20-60	20-60	25-60
No. 30	10-40	10-40	10-40
No. 200	0-12	0-12	3-12

702.2.2: Base material that does not meet Table 702-2 properties may be approved, at the Engineer's discretion, if the R-Value is a minimum of 70 when determined by test method AASHTO T-190.

702.2.3 Plasticity Index: Unless otherwise noted, the Plasticity Index as tested in accordance with AASHTO T-146 Method A (Wet Preparation), T-89 and T-90 shall not be more than 5.

Comment [DR8]: Table to be re-written by Mike Whitman

702.3 PROCESSED NATURAL MATERIAL:

702.3.1 General: Processed natural material shall consist of hard, durable fragments of stone or gravel and a filler of sand or other finely divided mineral matter. It shall be free from an excess of soft or disintegrated pieces, alkali, adobe, vegetable matter, loam, or other deleterious substances.

702.3.2 Physical Requirements: When sampled and tested in accordance with standard test methods, the aggregate shall meet the following requirements:

(A) Percentage of Wear: When tested in accordance with ASTM C-131, the percentage of wear shall not exceed 40 percent after 500 revolutions.

(B) Plasticity Index: When tested in accordance with AASHTO T-146 Method A (Wet Preparation), T-89 and T-90, the plasticity index shall not be more than 5.

(C) Liquid Limit: When tested in accordance with AASHTO T-89, the liquid limit shall not be more than 25 percent.

702.3.3 Crushed Material: Crushed material is not required, but may be incorporated in the finished product.

702.3.4 Grading: The aggregate shall conform to the sieve analysis in this specification except that the least dimension of the maximum particle size shall not exceed 2/3 of the compacted thickness of the specified lift being placed.

702.4 DECOMPOSED GRANITE:

Decomposed granite shall be any granitoid igneous rock which has been weathered in place and which has as principal constituents granular fragments of quartz and feldspar. It may also contain fragments of granitic rock not yet broken down into the component minerals. This material shall remain stable when saturated with water. Particles larger than 3 inches, which will not be broken in the process of rolling and tamping during construction, shall not be used.

SECTION ~~701~~703

~~Decomposed granite shall conform to the following requirements:~~

~~(A) When tested in accordance with this specification, not more than 20 percent shall pass the No. 200 mesh sieve.~~

~~(B) The P.I. of material passing the No. 200 sieve prior to testing shall not be less than 3 nor greater than 10. The Plasticity Index shall be tested in accordance with AASHTO T-146 Method A (Wet Preparation), T-89 and T-90.~~

~~**702.4.1 Preparation of Test Specimens:** A quantity of sufficient size to have a dry weight of 15 pounds shall be selected and dried to constant weight at a temperature between 215°F. and 230°F. Fifteen pounds of this material shall then be subjected to 500 revolutions in a Los Angeles abrasion machine, as described in Section 701, except that nothing shall be placed in the drum other than the material to be tested.~~

~~The material that has been subjected to the breakdown shall be tested in accordance with ASTM C-117 to determine the percentage of material finer than a No. 200 mesh sieve by washing.~~

End of Section

Case 11-30

DATE: July 13, 2011

TO: MAG Specification and Details Committee Members

FROM: Brian Gallimore, Materials Working Group/AGC

RE: Section 310-Untreaded Base Course

PURPOSE: Change title to clarify meaning. Addressed construction and evaluation process conflicting.

REVISIONS:
a) Classified compaction guidelines
b) Updated deficiency, corrective action and construction methods

SECTION 310

PLACEMENT AND CONSTRUCTION OF AGGREGATE BASE COURSE

310.1 DESCRIPTION:

Aggregate base course shall comply with Subsection 702 unless the use of a different type of material is specifically authorized in the special provisions.

310.2 PLACEMENT AND CONSTRUCTION:

The compacted lift thickness shall not exceed 6 inches, unless approved by the Engineer. Based on the type of material, type of equipment and compaction methods used, the Contractor may propose a greater lift thickness.

After distributing, the aggregate base course material shall first be watered and then graded to a uniform layer that will net, after compacting, the required thickness. The grading operation shall be continued to such extent as may be necessary to minimize segregation. The quantity of water applied shall be that amount which will assure proper compaction resulting in the density required by Section 310.3.

After placement, the aggregate base course surface shall be true, even and uniform conforming to the grade and cross-section specified. In no case shall the aggregate base course vary by more than ½ inch above or below required grade.

310.3 COMPACTION

The contractor is responsible for providing appropriate equipment and techniques to achieve the compaction results required by this specification. The aggregate base course shall be compacted in lift thicknesses as allowed by Section 310.2.

The laboratory maximum dry density and optimum moisture content for the aggregate base course material shall be determined in accordance with AASHTO T-99. Field 'one-point' maximum dry density and optimum moisture procedures shall only be allowed upon approval of the Engineer.

The in-place density shall be determined in the field by nuclear density testing in accordance with AASHTO T-310 or sandcone density testing in accordance with AASHTO T-191. In the event nuclear density testing is selected, a minimum of one sandcone correlation shall be performed for each 10 nuclear density tests.

A rock correction, to compensate for rock content larger than the #4 or ¾ inch sieves (as required by the laboratory maximum dry density and optimum moisture procedure selected), shall be performed in accordance with AASHTO T-224. Care should be taken to account for the specific gravity of the oversize particles particularly if recycled materials are utilized for aggregate base course. The specific gravity shall be determined in accordance with AASHTO T-85, as applicable.

For roadway construction, one field density test shall be performed per lift per 660 feet per lane. For other aggregate base course applications, a minimum of 1 field density test shall be performed for each 800 square yards. ~~More or less frequent testing may be performed at the approval of the Engineer.~~

Unless otherwise noted in the project plans or project specifications, the moisture content of the aggregate base course at the time of compaction shall be the optimum moisture content +/- 3%.

SECTION 310

The following percent compaction is required:

(A) Below asphalt concrete pavement	100%
(B) Below Portland cement concrete pavement, curb & gutter, attached sidewalk, roadway Shoulders, and other areas of the right-of-way subject to vehicular traffic	95%
(C) All other areas not subject to vehicular traffic	85%

Areas which fail initial testing for density and/or moisture content shall be reworked until passing tests for density and/or moisture content are achieved. Lower moisture content percentages at the time of field density testing may be allowed if significant time has passed since the time of compaction and the required density has been achieved.

310.4 THICKNESS AND/OR PLASTICITY INDEX DEFICIENCY:

When in the opinion of the Engineer there is reason to believe that a deficiency in thickness, or an excess of plasticity exists, measurements or samples will be taken in the same pattern as that defined in Section 321. If the base has been covered or it is otherwise impractical to correct the deficiency, the corrective measures in Table 310-1 shall be taken by the Contractor at no additional cost to the Contracting Agency.

TABLE 310-1

THICKNESS AND PLASTICITY DEFICIENCY

Type	Deficiency	Corrective Measure
I	Less than ½ inch of the required thickness	No corrective measure required.
II	½ inch or more but less than 1inch of the required thickness	(1) The contractor may choose to add additional material and rework the grade to meet the specification requirements. (2) The contractor may choose to increase the thickness of asphalt concrete by the amount of the aggregate base course thickness deficiency at no additional cost to the Owner. Required grade shall be met.
III	Thickness deficiency by greater than 1 inch	(1) The contractor will remove the aggregate base course and regrade the subgrade to allow the required aggregate base course layer thickness to be constructed. (2) If grades allow, the contractor may propose that the thickness of asphalt concrete be increased by the amount of the aggregate base course deficiency at no additional cost to the Owner.
IV	A plasticity index of 6 to 7 inclusive	(1) An Engineering Analysis (EA) may be prepared by the contractor to evaluate the expected performance of the aggregate base course layer. The EA may provide mitigation options for the Engineer to consider. If the Engineer accepts the plasticity index as a result of the EA, the material will be accepted at full payment. If the Engineer rejects the EA, the contractor will perform either option 2 or 3

		below. (2) The contractor may choose to reprocess or treat the existing material to bring it within specification limits or remove deficient material from affected area and replace with material complying with the specifications. (3) If grades allow, the contractor may increase the thickness of asphalt concrete by ½-inch at no additional cost to the Owner.
V	A plasticity index of over 7	(1) The contractor may choose to reprocess or treat the existing material to bring it within specification limits or remove deficient material from affected area and replace with material complying with the specifications.

310.4 PAYMENT:

Payment for aggregate base course will be made on the basis of the contract unit price per ton unless an alternate basis of payment is provided in the proposal.

SECTION 310

~~UNTREATED~~ PLACEMENT AND CONSTRUCTION OF AGGREGATE BASE COURSE

310.1 DESCRIPTION:

~~Untreated base, i.e., select or a~~Aggregate base course~~,~~ shall comply with Subsection 702~~.2~~ unless the use of a different type of material is specifically authorized in the special provisions.

310.2 ~~PLACING~~PLACEMENT AND CONSTRUCTION:

The compacted lift thickness shall not exceed 6 inches, unless approved by the Engineer. Based on ~~Aggregate~~ Untreated base ~~course shall be placed in lifts the height of which shall not exceed that which can be effectively compacted depending on~~ the type of material, type of equipment and compaction methods used, the Contractor may propose a greater lift thickness. ~~6 inches or less in compacted thickness may be placednot to exceed 12" in a single layer. Lifts in excess ofand those more than 6 inches in thickness shall be built up in successive layers of approximately equal compacted thickness not to exceed a maximum thickness of 6 inches. . The requirements which follow are applicable to all types of material.~~

After distributing, the aggregate base course material shall first be watered and then ~~immediately~~ graded~~bladed~~ to a uniform layer that will net, after compacting~~rolling~~, the required thickness. ~~If the materials deposited are not uniformly blended together, t~~The grading~~blading~~ operation shall be continued to such extent as may be necessary to minimize~~eliminate~~ segregation. The quantity of water applied shall be that amount which will assure proper compaction resulting in the~~a relative~~ density ~~of not less than 100 percent as determined under Section 301~~as required by Section 310.3.

~~Care shall be exercised in connection with watering operations to avoid wetting the subgrade or any lower base course to detrimental extent.~~

~~Upon completion~~After placement, the aggregate base course surface shall be true, even and uniform conforming to the grade and cross-section specified.

In no case shall the ~~Untreated~~a~~A~~ggregate base course ~~may~~ vary by~~not~~ more than ½ inch above or below required grade. ~~and cross-section.~~

310.3 COMPACTION

The contractor is responsible for providing appropriate equipment and techniques to achieve the compaction results required by this specification. The aggregate base course shall be compacted in lift thicknesses as allowed by Section 310.2.

~~The AASHTO procedures described in the section will be utilized unless the Engineer allows the corresponding ARIZ or ASTM procedure to be substituted.~~ The laboratory maximum dry density and optimum moisture content for the aggregate base course material shall be determined in accordance with ~~one of the following procedures: ARIZ 245, AASHTO T-99, or ASTM D698~~AASHTO T-99. Field 'one-point' maximum dry density and optimum moisture procedures shall only be allowed upon approval of the E~~e~~ngineer.

The in-place density shall be determined in the field by nuclear density testing in accordance with AASHTO T-310 ~~sandcone density testing and/or nuclear density testing. Sandcone density testing shall be performed in accordance with one of the following procedures: ARIZ 238, AASHTO T191, or ASTM D 1556 and/~~or~~.~~ sandcone density testing in accordance with AASHTO T-191~~Nnuclear density testing shall be performed in accordance with ARIZ 235, AASHTO T310, or ASTM D6 938~~. In the event nuclear density testing is selected, a minimum of one sandcone correlation shall be performed for each 10 nuclear density tests.

SECTION 310

A rock correction, to compensate for rock content larger than the #4 or ¾ inch sieves (as required by the laboratory maximum dry density and optimum moisture procedure selected), shall be performed in accordance with ~~one of the following procedures: ARIZ 227, AASHTO T224, or ASTM D4718~~AASHTO T-224. Care should be taken to account for the specific gravity of the oversize particles ~~especially~~particularly if recycled materials are utilized for aggregate base course. The specific gravity shall be determined –in accordance with ~~the one of the following procedures: ARIZ 210, AASHTO T85, or ASTM C127~~AASHTO T-85, as applicable.~~(How can you run C-127 on RAP or Asphalt Millings~~

~~One field density test shall be performed on each lift of aggregate base course.~~ For roadway construction, one field density test shall be performed ~~for~~per lift per ~~each~~ 66~~5~~0 feet per lane ~~width (Is this consistent)~~. For other aggregate base course applications, a minimum of 1 field density test shall be performed for each 800 square yards. ~~More or less frequent testing may be performed at the approval of the Engineer.~~

Unless otherwise noted in the project plans or project specifications, the moisture content of the aggregate base course at the time of compaction shall be the optimum moisture content ~~to~~ +/- ~~2~~3% ~~of optimum moisture content~~.

The following percent compaction is required:

(A) Below asphalt concrete pavement 100%

(B) Below Portland cement concrete pavement, curb & gutter, attached sidewalk, roadway Shoulders, and other areas of the right-of-way subject to vehicular traffic 95%

(C) ~~Below detached sidewalk or other flatwork~~All other areas not subject to vehicular traffic ~~85~~85~~90~~%

Areas which fail initial ~~field density~~ testing for density and/or moisture content shall be reworked until passing tests for density and/or moisture content are achieved. L~~l~~ower moisture content percentages at the time of field density testing may be allowed if significant time has passed since the time of compaction and the required density has been achieved.

310.4~~3~~ THICKNESS AND/OR PLASTICITY INDEX DEFICIENCY:

When in the opinion of the Engineer there is reason to believe that a deficiency in thickness, or an excess of plasticity exists, measurements or samples will be taken in the same pattern as that defined in Section 321. If the base has been covered or it is otherwise impractical to correct the deficiency, the corrective measures in Table 310-1 shall be taken by the Contractor at no additional cost to the Contracting Agency.

TABLE 310-1

THICKNESS AND PLASTICITY DEFICIENCY

Type	Deficiency	Corrective Measure
I	Less than ½ inch of the required thickness	No corrective measure required.
II	½ inch or more but less than 1 inch of the required thickness	~~Place asphalt chip seal using precoated chips in accordance with Section 330 for the full roadway width over the area involved but for not less than 660 feet or one City block in length.~~(1) The contractor may choose to add additional material and rework the grade to meet the specification requirements. ~~An Engineering Analysis (EA) shall be prepared by the contractor to evaluate the expected performance of the reduced aggregate base course layer. The EA may provide mitigation options for the Engineer to consider. If the Engineer accepts the in-place thickness as a result of the EA, a penalty of $1/ton shall be applied to the subject aggregate base coursethe Contractor shall reimburse the Agency for reduced aggregate base course quantities.~~ (2) The contractor may choose to ~~i~~increase the thickness of asphalt concrete by the amount of the aggregate base course thickness deficiency at no additional cost to the Owner. Required grade shall be met.
III	~~1 inch or more in t~~Thickness deficiency by greater than 1 inch	~~Place an additional asphalt concrete overlay, a 9.5 mm mix, of ½ the thickness of the deficiency in thickness for the full roadway width over the area involved, not less than 660 feet or one City block in length.~~(1) The contractor will remove the ~~A~~aggregate base course ~~removed~~ and regrade the sub~~b~~grade ~~regraded~~ to

		allow the required aggregate base course layer thickness to be constructed. (2) If grades allow, the ~~Engineer~~ contractor may propose that~~allow~~ the thickness of asphalt concrete ~~to~~ be increased by the amount of the aggregate base course deficiency at no additional cost to the Owner.
IV~~III~~	A plasticity index of 6 to 7 inclusive~~*~~	~~Place an asphalt concrete overlay ½ inch in thickness over the same total area as required for Type I and II.~~ (1) An Engineering Analysis (EA) ~~shall~~may be prepared by the contractor to evaluate the expected performance of the aggregate base course layer. The EA may provide mitigation options for the Engineer to consider. If the Engineer accepts the plasticity index as a result of the EA, the material will be accepted at full payment. If the Engineer rejects the EA, the contractor will perform either option 2 or 3 below. (2) The contractor may choose to reprocess or treat the existing material to bring it within specification limits or remove deficient material from affected area and replace with material complying with the specifications. (3) If grades allow, the contractor may increase the thickness of asphalt concrete by ½-inch at no additional cost to the Owner.~~If the Engineer accepts the in-place thickness as a result of the EA, a penalty of $1/ton shall be applied to the subject aggregate base course.~~
~~I~~V	A plasticity index of over 7~~*~~	(1) The contractor may choose to reprocess or treat the existing material to bring it within specification limits or ~~R~~remove deficient material from affected area and replace with material complying with the specifications.

~~* The plasticity index shall be in accordance with AASHTO T-146 Method A (wet preparation), T-89 and T-90.~~

310.4 PAYMENT:

Payment for aggregate ~~untreated~~ base course will be made on the basis of the contract unit price per ton unless an alternate basis of payment is provided in the proposal.

Effect of Fines Content and Plasticity on Aggregate Base Course Properties
MAG Working Group White Paper (8/17/11)

1.0 Discussion

Unbound granular aggregate road base is constructed to prevent pumping and volume change under load, have favorable drainage characteristics, and increase the structural capacity of the pavement section. This material derives its high stability, stiffness and strength from particle interlock and inter-particle friction. These engineering properties are developed from tight sand and gravel gradation ranges with particle size distributions that are well-graded and dense (Siswosoebrotho, et al, 2005).

Drainage capability is generally related to material permeability – a property that can conflict with the need for a rigid, dense section. In many regions the need for good drainage is essential to prevent volume change relating to freeze and thaw action. Moisture contents are kept very low to prevent temperature-related degradation of the aggregate base strength. Plastic fines are kept low to minimize water content, mitigate swell potential, and prevent reduction of inter-particle friction capacity.

Achieving required field compaction densities can be difficult with unbound granular aggregates having low percentages of fines (the percent passing the No. 200 sieve). However, the need for fines content must be balanced with the strength of the mix. Yoder and Witczak (1975) found that the effect of plasticity of the binder in aggregate blends has very little effect on strength when the percent passing the No. 30 sieve is relatively low. Strength is decreased as the amount of plastic binder is increased.

To determine an optimal mix for these competing properties, the stability of unbound aggregate road base mix used in flexible pavement design and construction is normally determined from the material resilient modulus value by either the California Bearing Ration test (CBR) or the resilient value (R-value) test. Compacted cylindrical molds are soaked and loaded to simulate a prototype pavement base in use. Structural coefficients for use in pavement design are estimated from resilient modulus values. ADOT's Materials Preliminary Engineering and Design Manual (ADOT, 1989) gives the relationship between R-value and base course structural coefficient in their Figure 202.02-5.

According to the ADOT manual, aggregate base course with an R-value of 79 or higher has a structural coefficient value of 0.14. For subbase material with an R-value of 70 to 78, the assigned structural coefficient is 0.11. For both materials, an R-value below 63 is considered subgrade.

Extensive regression and correlation analyses have been performed by ADOT using fines gradation, Plasticity Index (PI), liquid limit and Sand Equivalent to predict R-values of a wide range of soils and aggregates. This is done to provide a rapid method to validate index properties needed for pavement design and field construction management. The ADOT guide notes that these correlated index properties provide reasonable values when the following relationship between gradation and PI is used:

$$\log(\text{R-value at 300 psi}) = 2.0 - 0.006\,(\text{Percent passing No. 200 sieve}) - 0.017\,(\text{PI})$$

The ADOT manual provides Table 202.02-3 in their manual to represent the range of PI and gradation values developed from this equation.

MAG specifications limit aggregate base course PI to 5 and amount passing the No. 200 sieve to 12% (by weight). This correlates to an R-value of 70, or a structural number of 0.11 (when using the ADOT manual figures) and is consistent with a standard subbase material. MAG agencies use various aggregate base course structural values for their pavement design, ranging from 0.08 to 0.12, which is reasonably consistent with an R-value of 70 and the specified MAG PI and gradation limits for aggregate base course.

2.0 Application in Specifications

Most granular aggregate road base specifications limit PI to either 5 or 6 and the fines passing the No. 200 sieve from 8 to 15 percent (by weight). It is important to understand that these values vary based on region, local environmental conditions and the source/type of clay fines (swell potential). Source rock for aggregates also plays a major role in determining these index property limits.

The use of index properties for specifying ABC does not minimize the importance of the resilient modulus value and the testing of this engineering property. Index test are just that – a simple approximation of engineering properties. Direct testing of engineering properties gives a higher level of confidence than correlated index tests.

3.0 Recommendations

For agencies within Maricopa County, the importance of fines within aggregate base course is directly related to material stability, stiffness and strength. Base materials are rarely subject to freeze-thaw conditions and fines from local aggregate sources have minimal swell characteristics.

It is recommended that current plasticity index and gradation limits within MAG Section 702 remain as noted. Additional R-value referee testing should be included in the MAG section where there is the aggregate base mix has sufficient stability even though the index test values show the material in excess of the specified limits. The minimum R-value for acceptance should be 70, based on the average of 3 tests per 1000 tons, as long as no more than one test gives a low bound R-value between 70 and 67.

Other tests associated with source aggregate rock durability and angularity should remain.

This change gives the opportunity to use a wider range of aggregates blends with aggregate base course, taking advantage of the unique nature of various rock sources and offering the potential for improved placement with higher binder contents.

4.0 References

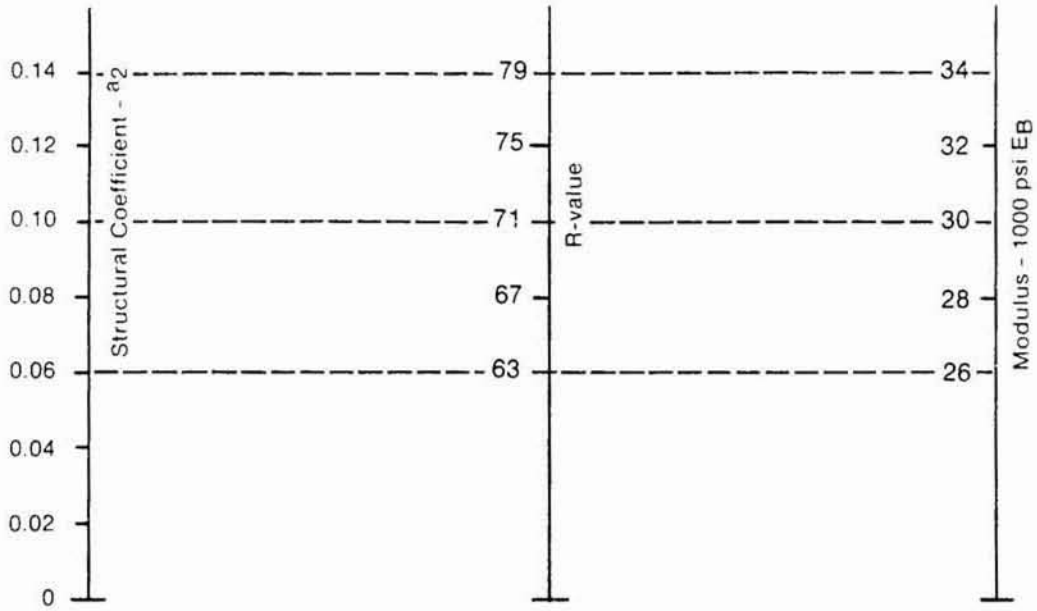
Arizona Department of Transportation Highways Department Materials Section (1989) Materials Preliminary Engineering and Design Manual, 3rd Ed.

Siswosoebrotho, B. I., Widodo, P., and Agusta, E. (2005) The Influence of Fines Content and Plasticity on the Strength and Permeabiity of Aggregate for Base Course Material, Proc: Eastern Asia Society for Transportation Studies, Vol. 5, pp. 845-856.

Yoder, E.J. and Witczak, M.W. (1975) Principles of Pavement Design, 2nd Ed., John Wiley & Sons, Inc., New York

FIGURE 202.02-5

Chart for estimating structural layer coefficient of unbound granular base determined by R-value or elastic modulus.



$a_2 = -0.2550 + 0.0050\ (\text{R-Value})$

$a_2 = -0.20 + 1.00 \times 10^{-5}(E_B)$

TABLE 202.02-3

BODY OF TABLE IS R-VALUE AT 300 psi EXUDATION PRESSURE

PERCENT PASSING #200 SIEVE

PI	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96
0	100	96	92	88	85	81	78	75	72	69	66	63	61	58	56	54	52	49	47	45	44	42	40	39	37	35	34	33	31	30	29	28	27
1	96	92	89	85	81	78	75	72	69	66	64	61	58	56	54	52	50	48	46	44	42	40	39	37	36	34	33	31	30	29	28	27	26
2	92	89	85	82	78	75	72	69	66	64	61	59	56	54	52	50	48	46	44	42	40	39	37	36	34	33	31	30	29	28	27	26	25
3	89	85	82	79	75	72	69	67	64	61	59	56	54	52	50	48	46	44	42	40	39	37	36	34	33	32	30	29	28	27	26	25	24
4	86	82	79	76	72	70	67	64	61	59	56	54	52	50	48	46	44	42	41	39	37	36	34	33	32	30	29	28	27	26	25	24	23
5	82	79	76	73	70	67	64	62	59	57	54	52	50	48	46	44	42	41	39	37	36	34	33	32	30	29	28	27	26	25	24	23	22
6	79	76	73	70	67	64	62	59	57	54	52	50	48	46	44	42	41	39	37	36	35	33	32	30	29	28	27	26	25	24	23	22	21
7	76	73	70	67	64	62	59	57	55	52	50	48	46	44	43	41	39	38	36	35	33	32	31	29	28	27	26	25	24	23	22	21	20
8	73	70	67	65	62	59	57	55	52	50	48	46	44	43	41	39	38	36	35	33	32	31	29	28	27	26	25	24	23	22	21	20	19
9	70	67	65	62	60	57	55	53	50	48	46	45	43	41	39	38	36	35	33	32	31	29	28	27	26	25	24	23	22	21	20	19	19
10	68	65	62	60	57	55	53	51	49	47	45	43	41	39	38	36	35	33	32	31	30	28	27	26	25	24	23	22	21	20	19	19	18
11	65	62	60	57	55	53	51	49	47	45	43	41	40	38	36	35	33	32	31	30	28	27	26	25	24	23	22	21	20	20	19	18	17
12	63	60	58	55	53	51	49	47	45	43	41	40	38	36	35	34	32	31	30	28	27	26	25	24	23	22	21	20	20	19	18	17	17
13	60	58	55	53	51	49	47	45	43	41	40	38	37	35	34	32	31	30	29	27	26	25	24	23	22	21	20	20	19	18	17	17	16
14	58	55	53	51	49	47	45	43	41	40	38	37	35	34	32	31	30	29	27	26	25	24	23	22	21	21	20	19	18	17	17	16	15
15	56	53	51	49	47	45	43	42	40	38	37	35	34	32	31	30	29	27	26	25	24	23	22	21	21	20	19	18	17	17	16	15	15
16	53	51	49	47	45	43	42	40	38	37	35	34	33	31	30	29	28	26	25	24	23	22	21	21	20	19	18	17	17	16	15	15	14
17	51	49	47	45	44	42	40	38	37	35	34	33	31	30	29	28	26	25	24	23	22	22	21	20	19	18	17	17	16	15	15	14	14
18	49	47	45	44	42	40	39	37	35	34	33	31	30	29	28	27	25	24	23	22	22	21	20	19	18	18	17	16	15	15	14	14	13
19	48	46	44	42	40	39	37	36	34	33	31	30	29	28	27	26	24	23	23	22	21	20	19	18	18	17	16	16	15	14	14	13	13
20	46	44	42	40	39	37	36	34	33	31	30	29	28	27	26	25	24	23	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12
21	44	42	40	39	37	36	34	33	32	30	29	28	27	26	25	24	23	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12	12
22	42	41	39	37	36	34	33	32	30	29	28	27	26	25	24	23	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12	12	11
23	41	39	37	36	34	33	32	30	29	28	27	26	25	24	23	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12	12	11	11
24	39	37	36	35	33	32	30	29	28	27	26	25	24	23	22	21	20	19	19	18	17	16	16	15	14	14	13	13	12	12	11	11	10
25	38	36	35	33	32	31	29	28	27	26	25	24	23	22	21	20	19	19	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10
26	36	35	33	32	31	29	28	27	26	25	24	23	22	21	20	19	19	18	17	16	16	15	15	14	13	13	12	12	11	11	10	10	10
27	35	33	32	31	29	28	27	26	25	24	23	22	21	20	19	19	18	17	16	16	15	15	14	13	13	12	12	11	11	10	10	10	9
28	33	32	31	30	28	27	26	25	24	23	22	21	20	19	19	18	17	17	16	15	15	14	13	13	12	12	11	11	10	10	10	9	9
29	32	31	30	28	27	26	25	24	23	22	21	20	20	19	18	17	17	16	15	15	14	13	13	12	12	11	11	10	10	10	9	9	9
30	31	30	28	27	26	25	24	23	22	21	20	20	19	18	17	17	16	15	15	14	13	13	12	12	11	11	11	10	10	9	9	9	8
31	30	29	27	26	25	24	23	22	21	20	20	19	18	17	17	16	15	15	14	14	13	12	12	11	11	11	10	10	9	9	9	8	8
32	29	27	26	25	24	23	22	21	21	20	19	18	17	17	16	15	15	14	14	13	12	12	11	11	11	10	10	9	9	9	8	8	8
33	27	26	25	24	23	22	21	21	20	19	18	17	17	16	15	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7
34	26	25	24	23	22	21	21	20	19	18	17	17	16	15	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7	7
35	25	24	23	22	22	21	20	19	18	17	17	16	15	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7	7	7
36	24	23	22	22	21	20	19	18	18	17	16	15	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7	7	7	6
37	23	23	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7	7	7	7	6
38	23	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7	7	7	7	6	6
39	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7	7	7	7	6	6	6
40	21	20	19	18	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10	10	9	9	8	8	8	7	7	7	7	6	6	6	6
42	19	19	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10	10	9	9	8	8	8	7	7	7	7	6	6	6	6	5	5
44	18	17	16	16	15	15	14	13	13	12	12	11	11	10	10	10	9	9	8	8	8	7	7	7	7	6	6	6	6	5	5	5	5
46	17	16	15	15	14	13	13	12	12	11	11	10	10	10	9	9	9	8	8	8	7	7	7	6	6	6	6	5	5	5	5	5	4
48	15	15	14	13	13	12	12	11	11	11	10	10	9	9	9	8	8	8	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4
50	14	14	13	12	12	11	11	11	10	10	9	9	9	8	8	8	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4
52	13	13	12	12	11	11	10	10	9	9	9	8	8	8	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3
54	12	12	11	11	10	10	9	9	9	8	8	8	7	7	7	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3
56	11	11	10	10	9	9	9	8	8	8	7	7	7	7	6	6	6	6	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3
58	10	10	10	9	9	8	8	8	7	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3
60	10	9	9	8	8	8	7	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3
62	9	8	8	8	7	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2
64	8	8	8	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2
66	8	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2
68	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2
70	6	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
72	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
74	6	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1
76	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1

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Case 11-31

DATE: August 17, 2011

TO: MAG Specifications and Details Committee Members

FROM: Peter Kandaris, SRP Representative

RE: **Revisions to Section 703 – Riprap; Section 220 – Riprap Construction**

Purpose: Update standard identified by Outside ROW WG

703 Revisions: The purpose of the changes is to simplify the language and include LA abrasion test requirement where deleted from revisions to Section 701 (Case 11-29).

Major changes are summarized below:

(a) Change the term “stone” to “aggregate” to be consistent with other MAG sections.

(b) Refer to corrected Section 701 subsections.

(c) Include engineering review of submittals and material source as is done with other materials (recommended by MCDOT).

(d) Place all material physical requirements in Section 703.2.

(e) Improve definition for aggregate shape and include appropriate ASTM test method.

220 Revisions: The purpose of the changes is to make the section compatible with revisions to Section 701 (Case 11-29) and update the grout material requirements.

Major changes are summarized below:

a) Change subsection reference to Section 701.

b) Delete “cookbook” grout mix in favor of mix performance criteria.

c) Provide parameters for ready-mix production of grout include use of fly ash, and specify coarse and fine aggregate gradation/distribution.

d) Eliminating field job mixing of grout as an option.

SECTION 703 – REVISED 8-17-11

RIPRAP

703.1 GENERAL:

Aggregate for grouted and ungrouted riprap shall meet the requirements of Sections 701.2 and 703.2 unless otherwise stated in the project specifications.

Aggregate shall be color-matched with adjacent landscape aggregate if specified on the plans or in the special provisions.

The Contractor shall provide the Engineer, in writing, material information and the source location at least 10 days prior to use of the material unless the material is currently acceptable for use as determined by the Engineer.

703.2 PHYSICAL PROPERTIES:

Riprap shall have the following physical properties:

(A) The maximum aggregate size shall be 150% of the indicated D_{50} size and the minimum aggregate size shall be 50% of the indicated D_{50} size.
(B) Aggregate shall be angular and shall not exceed 3:1 ratio for flat and/or elongated pieces when determined by ASTM D-4791. Rounded aggregate shall only be allowed when specified or approved by the Engineer.
(C) The loss by abrasion in the Los Angeles Abrasion Machine, determined as prescribed in ASTM C-535, shall not exceed 40 percent (by weight) after 1000 revolutions.

LA abrasion test requirements come from Section 701 for quarry stone.

SECTION 703 – REVISED 8-17-11

RIPRAP

703.1 ~~STONE~~GENERAL:

~~Stone~~ Aggregate for ~~plain and~~ grouted and ungrouted riprap shall meet the requirements of Sections ~~701.4~~ 701.2 and 703.2 unless otherwise stated in the project specifications. ~~Stone shall be angular, rounded stone shall only be allowed when specified. Flat or needle shapes will not be acceptable unless the thickness of the piece is more than 1/3 the length.~~

~~Stone~~ Aggregate shall be color-matched with adjacent landscape aggregate if specified on the plans or in the special provisions.

The Contractor shall provide the Engineer, in writing, material information and the source location at least 10 days prior to use of the material unless the material is currently acceptable for use as determined by the Engineer.

703.2 ~~SIZE OF STONE~~PHYSICAL PROPERTIES:

Riprap shall have the following physical properties:

(A) ~~Unless otherwise indicated t~~The maximum ~~stone aggregatge~~aggregate size shall be 150% of the indicated D_{50} size and the minimum ~~stone~~ aggregate size shall be 50% of the indicated D_{50} size.

(B) ~~Stone~~ Aggregate shall be angular and shall not exceed 3:1 ratio for ~~F~~flat and/or ~~needle~~elongated pieces when determined by ASTM D-4791. ~~shapes will not be acceptable unless the thickness of the piece is more than 1/3 the length.~~ Rounded ~~stone~~ aggregate shall only be allowed when specified or approved by the Engineer.

(C) The loss by abrasion in the Los Angeles A~~a~~brasion M~~m~~achine, determined as prescribed in ASTM C-535, shall not exceed 40 percent (by weight) after 1000 revolutions.

LA abrasion test requirements come from Section 701 for quarry stone.

SECTION 220 – REVISION 8-3-11

RIPRAP CONSTRUCTION

220.1 DESCRIPTION:

Riprap construction shall consist of furnishing and placing stone, with or without grout, and underlain with filter material of granular filter blankets or erosion control geosynthetic fabric. The depth and type of riprap shall be as shown on the plans or in the special provisions.

220.2 MATERIALS

Riprap shall conform to the requirements of Section 703.

Erosion control geosynthetic fabric shall conform to the requirements of Table 796-3 in Section 796.

Waste or sacked concrete shall not be permitted for use as riprap.

The Contractor, at no additional cost, shall provide mechanical equipment, a sorting site, and labor needed to assist in checking riprap gradation.

Granular filter blankets shall consist of processed natural material conforming to the requirements of Section 701~~2.3~~, with the gradation and thicknesses as specified on the plans or in the special provisions.

220.3 PREPARATION OF GROUND SURFACES

The bed for placement of riprap shall be shaped and trimmed to provide even surfaces.

220.4 PLACEMENT OF EROSION CONTROL GEOSYNTHETIC FABRIC:

Fabric shall be placed at the locations shown on the project plans. The Contractor shall provide a surface free of obstructions, depressions, debris, and soft yielding surfaces prior to the placement of fabric. The fabric shall be loosely laid (not in a stretched condition), aligned and placed with no fold over wrinkles.

The fabric shall be placed to provide a minimum 24-inch of overlap for each joint. On horizontal joints, the uphill fabric shall overlap the downhill fabric. On vertical joints, the upstream fabric shall overlap the downstream fabric.

Bedding material shall be placed uniformly on the fabric to the depth specified on the plans and shall be free of mounds, dips, and windrows. Bedding material shall not be compacted.

220.5 RIPRAP PLACEMENT:

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Riprap shall be carefully placed on filter material consisting of a granular filter blanket or the bedding material on erosion control geosynthetic fabric. Placement shall not damage the underlying filter blanket or geosynthetic fabric. If the Engineer determines that the placement of stone has damaged or displaced the filter material to the extent that it cannot function as intended, the Contractor, at his expense, shall remove the placed riprap stone and properly correct the damage to, and/or the displacement of, the filter material. Such correction may include the removal of the filter material, re-grading the affected area, and subsequent replacement of the filter material and riprap stone as required by the Engineer.

Riprap shall be placed in a manner which will produce a dense, reasonably well-graded mass without segregation and with a minimum amount of voids. The larger stone shall be evenly distributed through the riprap mass. The individual placement of larger riprap stones may be required to obtain a uniform distribution of stone size. The riprap placement shall be supplemented by such hand methods as are required to obtain a uniform finished surface. Allowable tolerance from the slope lines and grades shown for the finished riprap surfaces shall not exceed a distance equal to 1/3 of the nominal D_{50} size above or below the design surfaces. The final surface elevations shall be lower than any adjacent apron or pipe invert elevations and shall not obstruct the operation of adjacent structures. The flow line within riprap shall provide positive drainage with minimal ponding. Individual stones shall depress below the finished grades no lower than a distance equal to 1/2 of the nominal D_{50} size. Special care shall be exercised in placing riprap within 3 feet of structures to avoid damage to such structures.

220.6 GROUTED RIPRAP:

Place riprap as specified in Section 220.5, excluding the use of filter material~~, then grout~~ and secure in place with portland cement ~~mortar~~ grout meeting the requirements of Table 220-1. Place grout to the depth as shown on the plan but in no case less than 70 percent of the depth of riprap. Consolidate grout into place with suitable spades, trowels or other approved means to provide a dense stone and mortar layer with all voids and interstices filled. After grout has been placed, the rocks shall be thoroughly brushed so that their top surfaces are exposed. If required, use water pressure to clean stone faces after the mortar has achieved sufficient strength. The outer rocks shall project 1/3 to 1/4 their diameter above the grouted surface.

Table 220-1 Grout for RipRap

Minimum Cementitious Material (lbs)	Maximum W/CM Ratio	Slump (in)	Air Content (%)
850	0.60	9 +/- 2	0 % - 8 %

~~The grout shall consist of 1 part cement and 3 parts by volume of aggregate.~~ The ~~portland cement~~ cementitious materials shall meet the requirements ~~be Type II as specified in~~ of Section 725.2. Up to 25 percent by weight of the Table 220-1 minimum cementitious materials requirements may be an approved fly ash or natural pozzolan. The aggregates shall meet the applicable requirements of ASTM C-33, #8 (3/8") coarse aggregate grading and fine aggregate

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(sand) grading. All Ready Mixed Grout volume calculations shall be based on "absolute volume" with the total volume per cubic yard equal to 27 cubic feet. Coarse aggregate volume shall be a maximum of 35% of the total aggregates volume. ~~shall be 2 parts sand and 1 part gravel passing a 3/8 inch square mesh screen. The quality of the sand and gravel~~ **shall** ~~be as specified in~~ Section ~~701~~. All mixing shall be in accordance with the applicable requirements of Section 725.7.

The amount of ~~water~~ slump shall be the minimum amount needed ~~such as~~ to permit gravity flow into the interstices with limited spading and brooming. The consistency of the grout shall be as approved by the Engineer.

~~Except when hand mixing is permitted by the Engineer, grout shall be mixed in an approved machine mixer for not less than 1 1/2 minutes. Should hand mixing be permitted, the cement and aggregate shall be thoroughly mixed in a clean, tight mortar box until the mixture is of uniform color after which clean water shall be added in such quantity as to provide a grout of the required consistency.~~

220.7 MEASUREMENT:

The completed, in place riprap construction within the limits of the dimensions shown on the plans shall be measured. Measurement will be in cubic yards rounded to the nearest cubic yard.

No separate measurement will be made for erosion control geosynthetic fabric, bedding material, or grout.

220.8 PAYMENT:

Payment for riprap will be made for the accepted complete in-place riprap construction at the contract unit price. Riprap construction shall include excavation, ground surface preparation, erosion control geosynthetic fabric (if used for the project), bedding material, riprap stone, grout (if used for the project) and backfilling.

Payment for riprap shall be full compensation for furnishing all material, labor and equipment for riprap construction.

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Case 11-32

DATE: July 13, 2011

TO: MAG Specification and Details Committee Members

FROM: Brian Gallimore, Materials Working Group/AGC

RE: Section 309 – Lime Slurry Stabilizing

PURPOSE: Section 309 needed to be modified to include the use of hydrated lime and not just be a slurry spec. Allow the spec to be used for soil modifications.

REVISIONS:
a) Revise title to include soil modification
b) Add mix design criteria
c) Add additional testing procedures
d) Specify equipment to be used to spread material more accurately
e) Be non-specific on compaction equipment
f) Payment for lime materials

SECTION 309

LIME ~~SLURRY~~ STABILIZATION OR MODIFICATION OF SUBGRADE

309.1 DESCRIPTION:

This section shall consist of constructing a mixture of soil, lime and water for the stabilization or modification of subgrade soils. ~~or base materials.~~ The work shall be performed in conformity with the lines, grades thickness, and typical cross sections shown on the plans.

Lime Stabilization involves improving soil conditions as defined within this specification. Lime Modification can be allowed by the Engineer in the event only limited soil improvement is required.

309.2 MATERIALS:

309.2.1 Soil or Subgrade: For Lime Stabilization applications, t~~T~~he soil or subgrade material used for this work shall consist of materials on the site or imported and shall be free of roots, sod, weeds and stones larger than 3 inches and have a Plasticity Index (PI) greater than 10, when tested in accordance with AASHTO T-89 & T-90. For Lime Modification applications, the allowable soil or subgrade properties will be determined by the Engineer.

309.2.2 Quicklime and Hydrated Lime: Lime used to manufacture the commercial lime slurry specified herein, shall be either quick lime or hydrated lime and shall conform to the requirements of ASTM C-977. ~~Lime may only be used in the production of a lime slurry. The direct use of dry hydrated lime or quicklime to the soil material is strictly prohibited.~~ All lime shall come from a single source. If a source change is requested, a new mix design shall be submitted using lime from the proposed new source. The new design must be approved by the Engineer prior to use.

309.2.3 Commercial Lime Slurry: Commercial lime slurry shall be a pumpable suspension of solids in water. The water or liquid portion of the slurry shall not contain dissolved material in sufficient quantity naturally injurious or objectionable for the purpose intended. The solids portion of the mixture, when considered on the basis of solids content, shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

(A) Chemical Composition: The solids content of the lime slurry shall consist of a minimum of 90% by weight, of calcium and magnesium oxides (Ca0 and Mg0), as determined by ASTM C-25.

(B) Residue: The percent by weight of residue retained in the solids content of lime slurry shall conform to the following requirements:

Residue retained on a No. 6 sieve	Max.	0.2%
Residue retained on a No. 30 sieve	Max	4.0%

(C) Grade: Commercial lime slurry shall conform to a dry solids content as approved by the Engineer.

A certificate of compliance and a field summary of lime slurry produced shall be provided to the Engineer for each load of slurry.

309.2.4 Water: Water used for mixing or curing shall be reasonable clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water shall be tested in accordance with and shall meet the suggested requirements of AASHTO T-26. Water known to be of potable quality may be used without test.

309.3 COMPOSITION:

309.3.1 Lime~~ Slurry~~: Lime ~~slurry~~ shall be applied at the mix design rate for the depth of subgrade stabilization or modification shown on the plans or requested by the Engineer.

309.3.2 Mix Design: Before commencing lime treatment work, the Contractor shall submit for approval by the Engineer, a proposed mix design. The proposed mix design shall be prepared by a testing laboratory under the direction and control of a registered Professional Engineer. The mix design shall be determined using the soils or subgrade material to be stabilized or modified and lime from the proposed supplier and shall determine the following:

(a) Percent of lime and rate of application of quicklime or lime slurry in the treated soil or subgrade material to meet the design specifications.
(b) Optimum water content during mixing, curing and compaction.
(c) Gradation of in-situ mixture after treatment.
(d) Additional mixing or equipment requirements.
(e) Sulfate content. The sulfate content of the subgrade soil shall be determined by ARIZ 733, AASHTO T290, or ASTM C1580. This result will be reported in the design. The sulfate content will allow the mix designer to recommend the appropriate mellowing time.
(f~~e~~) Mellowing time requirements to provide the contractor with the appropriate time frames for the lime reaction with the soil to be effective.~~, if needed.~~

For Stabilization applications, ~~T~~the mix design shall comply with the following requirements:
(a) pH: Minimum 12.~~4~~ after compaction of initial mixing with lime at ambient temperature, in accordance with Eades-Grimm pH test method (ASTM C 977 APPENDIX or ASTM D6276).
(b) Plasticity Index: Less than 3, per AASHTO T-89 & T-90.
(c) Swell Potential: ~~One (1) percent or less vertical expansion of an air dried soil when inundated with water and allowed to swell at a confined pressure of 60 psf.~~Maximum expansive potential (%) of 1.0. The maximum expansive potential shall be determined on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at approximately 2% below optimum moisture content. The sample should be confined under a 100 psf surcharge and submerged/inundated.
(d) Hydrated Lime Content: The design engineer shall ~~specify~~designate the m~~M~~inimum ~~5.0~~ percentage of lime by dry weight of the combined lime/soil mixture to ~~accomplish~~satisfy the criteria above. The percentage of ~~cement~~lime specified shall ~~also~~ be sufficient to ~~overcome~~allow for expected variations during the mixing process~~, per ASTM D-3155~~.
(e) Unconfined Compressive Strength: Minimum 160 psi in five days curing at 100°F. when tested in accordance with ASTM D-1633 Method A or an alternate compressive strength method approved by the Engineer~~.~~

For Soil Modification purposes only, the mix design shall specify the minimum amount of quicklime or ~~Hydrated~~hydrated lime slurry required to meet the desired improved soil properties.

309.3.3 Tolerance: At final Compaction, the lime and water content for each course of subgrade treatment shall conform to the approved mix design with the following tolerance:

Material	**Tolerance**
Lime	+0.5% of design, (ASTM C-114)
Water	~~+4%, -0% of o~~Optimum to optimum +4%, (ASTM D-698)

309.4 CONSTRUCTION:

309.4.1 General: It is the primary requirement of this specification to secure a completed subgrade containing a uniform lime mixture, free from loose segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses.

Prior to beginning any lime ~~slurry~~ stabilization or modification, the subgrade shall be constructed and brought to grade and shall be shaped to conform to the typical sections, lines and grades as shown on the plans.

When the design requires treatment to a depth greater than 12 inches, the subgrade soil shall be treated in equal layers. The top layer(s) of soil shall be removed and stockpiled. The lower layer of soil to be treated shall then be treated and allowed to cure in place. After final mixing, the lower layer shall be compacted in maximum 12 inch thick compacted lifts. The stockpiled soil shall then be placed, treated, mixed and compacted in successive maximum 12 inch thick compacted lifts.

309.4.2 Weather Limitation: Lime ~~slurry~~ treated subgrade shall not be constructed if the ~~atmospheric~~ ambient temperature is below 40° F. or when conditions indicate that temperatures may fall below 40° F. within 24 hours.

309.4.3 Equipment: Contractor shall provide all equipment necessary to complete the work including grading and scarifying equipment, a spreader of the lime, ~~slurry (gravity feed spreader, will not be permitted),~~ mixing and pulverizing equipment, sheepsfoot and pneumatic rollers, sprinkling equipment and trucks. Gravity feed or tailgate spreading, defined as not having automatic controls, will not be permitted. The spreader shall demonstrate the ability to maintain a consistent spread rate over variable travel speeds.~~When using dry hydrate to make slurry, agitators are mandatory in distributor trucks.~~ All equipment used for this work is subject to approval by the Engineer.

309.4.4 Application: Lime ~~slurry~~ shall be spread only on that area where the mixing operation can be completed during the same working day. ~~The application and mixing of lime with the soil shall be accomplished by the methods hereinafter described as Slurry Placing.~~

309.4.4.1 Dry Hydrated Lime or Dry Quicklime Application: Hydrated lime or quicklime shall only be applied by approved spreader trucks equipped with operating dust collectors to minimize dust issues while loading. Additionally, dust control measures must be observed during the spreading and soil mixing of dry lime.

309.4.4.2 Slurry Application:~~Slurry Placing:~~ Lime slurry shall be mixed in a portable mixing unit and spread with trucks equipped with an approved distribution system as a slurry. Commercial lime slurry shall be applied at the~~with a~~ lime percentage determined by the mix design.~~not less than specified herein. The distribution of lime slurry shall be attained by successive passes over a measured section of subgrade until the proper amount of lime has been spread, as determined in the job mix design~~. ~~The rate of application shall be verified using the methods outlined by ASTM D 3155.~~ The contractor shall provide the Engineer with the daily production quantities for the lime slurry.

Thickness: The thickness of the lime ~~slurry~~ treated subgrade shall be determined by visual inspection and/or by depth tests taken at intervals so that each test shall represent no more than 1000 square yards per layer. If more than one layer, the method used to remove material to determine the depth of lime treatment may be by shovel and/or pick, coring or other method approved by the Engineer. Phenolphthalein solution shall be used to detect the presence of lime. When the grade deficiency is more than 1 inch, the Contractor shall correct such areas in a manner satisfactory to the Engineer. Contractor shall replace, at no cost to the Agency, the material where depth tests are taken.

No traffic other than the mixing equipment will be allowed to pass over the spread of lime ~~slurry~~ until after completion of mixing.

The Engineer reserves the right to vary the rate of application of lime from the specified application rates during the progress of construction as necessary to maintain a pH of the lime/soil mixture above 12.0~~4~~ and the desired characteristics of the treated subgrade.

309.4.5 Mixing: The full depth of the treated subgrade shall be mixed with an approved mixing machine. The use of disc plows or blades are strictly prohibited except in areas specified by the engineer. To insure a complete chemical reaction of the lime and soil or subgrade, water shall be used as required to maintain a minimum moisture content 4% above the optimum prior to beginning compaction and held at optimum to +4% of ~~0-4% above~~ optimum during compaction. During the interval of time between application and mixing, lime that has been applied, unmixed and exposed to the open air for 10 hours or more will not be accepted.

After mixing and prior to compaction, clay lumps shall meet the following criteria:

	Percent
Minimum of clay lumps passing 1-1/2 inch sieve	100
Minimum of clay lumps passing No. 4 sieve	60

309.4.6 Compaction: Compaction of the mixture shall begin after final mixing and shall be accomplished in accordance with the design specifications. ~~Sheepsfoot or segmented sheel rollers shall be used during initial compaction. Steel wheel or pneumatic tired rollers shall be used only during final compaction.~~ Areas inaccessible to conventional rolling equipment ~~rollers~~ shall be compacted to the required density by methods approved by the Engineer.

The material shall be aerated or watered as necessary to provide and maintain required moisture content. The field density of the compacted mixture shall be at least 95 percent of the maximum wet density at optimum to + 4% of ~~0-4% above~~ optimum moisture content. A composite of untreated soil or subgrade materials from a minimum of five (5) random locations, per soil type, within the area to be stabilized shall be used to determine the maximum wet density and optimum moisture content in accordance with ASTM D-558. The in-place ~~filed~~ compacted field density shall be determined in accordance with ASTM D-1556, ASTM D-2167 or ASTM D-6938~~2922~~. The adjustment for rock larger than the no. 4 sieve shall be performed in accordance with ARIZ 227c.

After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked to meet requirements.

If pumping subgrade should become evident at any time prior to paving, the Engineer may require proof rolling with a pneumatic-tire roller or other approved equipment in order to identify the limits of the unacceptable area. The proof rolling will be performed at no additional cost to the Contracting Agency.

All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereupon or the work is accepted. Compaction and finishing shall be done in such a manner as to produce a smooth dense surface free of compaction planes, cracks, ridges or loose materials.

Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion, shall be smooth and shall conform with the typical section shown on the plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at no cost to the Agency.

309.4.7 Finishing and Curing: After the final layer or course of lime treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the plans. The completed section shall then be finished by rolling with a pneumatic or other suitable roller.

~~The final~~Each layer of lime treated subgrade shall be maintained in a moist condition until the next layer of pavement structure is placed. If required, a fog seal for curing, in compliance with MAG S~~s~~ection 333, shall be furnished and applied to the surface of the final layer of the lime stabilized material as soon as possible after the completion of final rolling and before the temperature falls below 40° F. Curing seal shall be applied at a rate between 0.10 and 0.20 gallons per square yard of surface. The exact rate will be determined by the Engineer.

After curing begins, all traffic, except necessary construction equipment shall be kept off the lime stabilized subgrade for a minimum of 7 days or until the final pavement structure layer(s) are placed. As an alternative, the contractor may place a loose lift of aggregate base course over the curing subgrade. The aggregate base course should be kept moist during the curing process.

309.4.8 Maintenance: The Contractor shall maintain, at his/her own expense, the entire lime ~~slurry~~ treated subgrade in good condition from the start of work until all the work has been completed, cured and accepted by the Engineer.

309.5 MEASUREMENT:

The quantity of lime slurry treated soils shall be measured by the square yard, measured in place, treated, compacted, to the proper depth, and accepted.

The quantity of curing seal shall be measured by the ton.

309.6 PAYMENT:

The lime ~~slurry~~ treated soils measured as provided above, will be paid for at the contract price per square yard, which price shall be full compensation for the item complete, as herein described and specified.

The Owner or Engineer reserves the option to pay for the lime separately. Should this option be chosen, the lime treated soils measured as provided above will be paid for at the contract price per square yard which shall include full compensation for the item less lime, as herein described and specified. The Lime materials will be paid for by the contract price per ton based on hydrated lime. If quicklime is used there will be an additional pay factor of 1.3 applied to determine the actual amount of hydrated lime placed.

Payment for curing seal will be by the ton, based on the rate of application as requested by the Engineer.

Case 11-33

DATE: July 13, 2011

TO: MAG Specification and Details Committee Members

FROM: Brian Gallimore, Materials Working Group/AGC

RE: Section 311 - Soil Cement Base Course

PURPOSE: Clarify and update the construction methods of cement treated subgrade

REVISIONS:
a) Clarify title description of cement treated base course to subgrade
b) Spreading of cement
c) Update testing criteria for moisture and density
d) Add thickness deficiency procedure
e) Remove bituminous curing seal for environmental reasons

SECTION 311

PLACEMENT AND CONSTRUCTION OF CEMENT TREATED SUBGRADE~~SOIL CEMENT BASE COURSE~~

311.1 DESCRIPTION:

This item shall consist of a cement treated ~~subgrade~~sub grade ~~base course~~ composed of a mixture of local soil, portland cement, and water compacted at optimum moisture content.

311.2 MATERIALS:

Portland cement and water shall comply with Sections 725 and 225. The soil for the mixture shall consist of the material in the area to be paved. The material shall not contain more than 5 percent gravel or stone retained on a 3 inches sieve. It shall be demonstrated by laboratory tests that the plasticity and strength~~hardening~~ characteristics as defined in Section 311.4.5 of the soil will be adequately modified by the specified cement content.

311.3 EQUIPMENT:

An ample number of machines, combination of machines and equipment shall be provided and used to produce the complete soil cement treated layer~~base course r~~ meeting the requirements for soil pulverization, cement distribution, water application, incorporation of materials, compaction, finishing, and for application of the curing material as provided in these specifications.

Mixing shall be accomplished by means of multiple-pass soil-cement mixer, single-pass soil-cement mixer or central plant mixer.

Water may be applied through the mixer or with the water trucks equipped with pressure sprays. Water trucks providing fine fog-type sprays shall be furnished for finishing and curing. Properly adjusted garden type nozzles on a pressure bar may be used to produce fog spray if approved by the Engineer.

Cement spreader shall be a specially constructed device to distribute bulk cement at the specified rate. The spreader shall have the ability to maintain a consistent spread rate over variable travel speeds. ~~uniformly at rate specified either in windrows or on the flat as determined by method of mixing.~~

311.4 CONSTRUCTION METHODS:

Prior to ~~Before undertaking~~ construction, the contractor shall remove all deleterious material, organic material, and particles retained on the 3 inch sieve from the area to be treated. ~~of the soil~~. The soil ~~of the cement base course, the area to be paved~~ shall be brought to a compacted condition, true to line and grade as directed by the Engineer or as shown on the plans. ~~During this process any unsuitable soil or material, including excess material retained on a 3 inches sieve, shall be removed and replaced with acceptable material. The compacted surface shall be at the proper elevation as specified, shown on the plans, or as directed by the Engineer, for the top of the soil cement base. At completion of this phase, the material and surface shall be approved by the Engineer before proceeding with the next step.~~ The compacted soil and surface shall be approved by the Engineer prior to proceeding with mixing.

The material shall be scarified, pulverized, mixed with water and cement, compacted, ~~and~~ finished and cured in lengths permitting the full roadway width to be complete in not more than 4 hours from the time that cement is exposed to water. Such lengths will generally be not less than 600 feet or the length of one City block and preferably more. Where a gutter section exists the material shall be pulled back from the gutter face for the full depth of the course before processing.

SECTION 311

311.4.1 Pulverizing: ~~Before~~ Prior to application of cement, soil to be processed shall be scarified to depth of base. The material ~~should~~ shall be damp at time of scarifying to reduce the dust generation ~~to a minimum~~ and to aid in pulverization. ~~If the soil contains clods, it~~ Soil shall be pulverized until not less than 80 percent, exclusive of gravel or stone, will pass a No. 4 sieve.

311.4.2 Application of Cement: The quantity of cement shall be by weight as a percentage of the dry weight of the soil as determined by the laboratory and/or as directed by the Engineer and shall be applied uniformly on the soil in a manner satisfactory to the Engineer. The allowable deviation in uniformity shall not exceed 10 percent. The entire operation of spreading and mixing shall be conducted in such a manner as will result in a uniform soil cement and water mixture for the full design width and depth.

The percentage of moisture in the soil, at the time of cement application, shall not exceed the quantity that will permit a uniform and intimate mixture of the soil and cement during mixing operations, and it shall not exceed the specified optimum moisture content for the soil cement mixture.

311.4.3 Mixing: Mixing with addition of water as required shall be continued until the product is uniform in color and at optimum moisture content to + 4% of optimum moisture content as determined in accordance with ASTM D-558. Any mixture of soil and cement which has not been compacted and finished shall not remain undisturbed for more than 30 minutes but shall be agitated by remixing.

311.4.4 Optimum Moisture: Optimum moisture requirements and field tests of moisture density shall be determined in accordance with ~~AASHTO T-134, T-191, T-217, or~~ ASTM D-558, ~~D-2922, D-3017~~ and D6938 on representative samples of soil cement mixture obtained from the area being processed. At the time of compaction~~laydown~~, the moisture content shall not be below optimum moisture, and shall be less than that quantity which will cause the base course to become unstable during the compaction and finishing process. Any area which becomes so unstable shall be removed and replaced with new cement stabilized material.

311.4.5 Compressive Strength: Laboratory compressive strength testing of the cement~~ed~~ treated subgrade is required to evaluate the proposed amount of cement and/or verify the compressive strength achieved during construction. Laboratory compressive strength testing shall be done in accordance with ARIZ 241~~a~~.

311.4.6~~5~~ Compaction: After mixing is complete, the mixture shall be carefully placed in a uniform loose depth which will provide a surface true to grade and section when compacted. Unless otherwise directed by the Engineer, initial compaction shall be by means of a tamping, grid, or pneumatic roller. After the tamping roller has partially walked out, pneumatic rollers shall be used. Density of final product shall be not less than 95 percent as determined by ~~AASHTO or~~ ASTM standards as specified above.

SECTION 311

311.4.7~~6~~ Finishing: As compaction nears completion, the surface of the base course shall be shaped to required lines, grades and cross-section. When required, the surface shall be lightly scarified with spike tooth harrows or other approved equipment to remove imprints left by equipment or to prevent slippage planes. During the finishing process the surface shall be kept moist by means of fog-type sprays. Surface finish and final compaction shall be completed in not more than 2 hours from the time the cement is exposed to water~~time of laydown~~. The completed base course shall be true to line, grade, cross-section and shall not vary more than ½ inch in thickness and not more than 1 inch in surface tolerance when tested with a 10 foot straight edge. It shall be free of surface cleavage planes, cracks, or loose material. As a final operation, the surface shall be very lightly scalped with a motor grader, wet with a fog spray and rolled with a pneumatic roller as directed by the Engineer.

311.4.8~~7~~ Thickness Deficiency: ~~When in the opinion of the Engineer there is reason to believe that a deficiency in thickness exists, cores will be taken in the same pattern as that defined in Section 321. If the base has been covered or it is otherwise impractical to correct the deficiency, the corrective measures, listed in Table 310-1 for Type I or II deficiencies, shall be taken by the Contractor at no additional cost to the Contracting Agency.~~The Engineer may choose to have cores obtained to evaluate the thickness of the treated cement stabilized subgrade layer. Should the thickness of the treated layer not meet the project specifications, the Engineer may require the contractor to submit an Engineering Analysis (EA) to address the pavement section. The EA will provide an opinion as to the anticipated performance of the pavement section as a result of the reduced cement treated layer thickness.

311.4.9~~8~~ Curing: ~~After completion of the final finishing process, the soil-cement shall be cured with a bituminous curing seal applied at the end of each construction day. This seal may be either an emulsion or cut-back asphalt applied at a minimum rate of 0.20 gal./sq. yd. The finished soil-cement shall be kept continuously moist until the bituminous cure seal is applied, using fog or gravity bar spray. The spray equipment shall be approved by the Engineer before construction is begun.~~~~The final~~Each layer of cement treated subgrade shall be maintained in a moist condition until the next layer of pavement structure is placed. If required, a fog seal for curing~~,~~ in compliance with MAG Section 333, shall be furnished and applied to the surface of the final layer of the cement stabilized material as soon as possible after completion of final rolling and before the ambient temperature falls below 40º F. Curing seal shall be applied at a rate between 0.10 and 0.20 gallons per square yard of surface. The exact rate shall be determined by the Engineer.

After curing begins, all traffic, except necessary construction equipment shall be kept off the cement stabilized subgrade for a minimum of 7 days or until the final pavement structure layer(s) are placed. As an alternative, the contractor may place a loose lift of aggregate base course over the curing subgrade. The aggregate base course shall be kept moist during the curing process.

311.4.10~~9~~ Construction Joints: At the end of each day's work, a construction joint shall be made transverse to the centerline of the road by cutting back into the work to provide a full depth vertical joint. Except where specifically authorized by the Engineer, no other construction joints will be permitted. Where authorized, such joints shall be full depth vertical joints.

311.4.11~~10~~ Maintenance: The Contractor shall maintain the surface until it has been covered with the designated bituminous wearing course. In case it is necessary to replace any soil cement, it shall be for the full depth. No skin patches or soil cement will be permitted. Minor surface pits may be filled with compacted bituminous surfacing, if authorized by the Engineer. Immediately prior to the placing of the bituminous wearing course, the surface shall be broomed to removed all loosened material from the surface.

311.5 MEASUREMENT:

SECTION 311

Measurement of soil cement will be the number of square yards constructed to the required depth, completed and accepted.

Measurement of portland cement will be the number of tons of cement mixed with local soil.

311.6 PAYMENT:

Payment will be made for the applicable items at the contract unit prices bid in the proposal, and shall constitute full payment for furnishing all material, equipment, tools, labor and incidentals necessary to complete the work and for carrying out the maintenance provisions.

No measurement or payment will be made for any imported earth materials.

End of Section

Case 11-34

DATE: July 13, 2011

TO: MAG Specification and Details Committee Members

FROM: Brian Gallimore, Materials Working Group/AGC

RE: Section 312 - Cement Treated Base

PURPOSE: Section 312 need update testing procedures

REVISIONS:
a) Added provisions for measuring moisture content
b) Updated density testing methods procedures

SECTION 312

CEMENT TREATED BASE

312.1 DESCRIPTION:

Cement treated base shall consist of a combination of base material and portland cement as specified in Section 705.

312.2 GENERAL:

When the mixing of cement treated base in a stationary mixer is required, it will be so specified. Otherwise, cement treated base may be mixed in either a traveling plant or in a stationary plant, at the option of the Contractor.

If the cement treated aggregate is mixed in a central plant, it shall not contain moisture in excess of 1 percent above or below optimum at the time of delivery on the grade. Certain types of transit mixers will not discharge such material unless it is greatly in excess of optimum moisture. Use of such mixers will not be permitted.

If the material is mixed in place, the machine or combination of machines used shall be capable of thoroughly mixing the cement and aggregate, when using the granular material specified, in a single pass. No lift thickness shall exceed 8 inches. If the thickness required is in excess of 8 inches, it shall be mixed in 2 separate lifts of equal thickness.

312.3 CONSTRUCTION METHODS:

Mixing of materials, regardless of the type of mixer used or method employed, shall be continued until the cement and water are evenly distributed throughout the aggregate, and a mixture of uniform appearance is obtained.

The amount of cement used shall conform to requirements of Section 705. Cement delivered in standard sacks from commercial producers will be assumed to weigh 94 pounds per sack and need not be weighed. Bulk cement or fractional sacks of cement shall be weighed.

The amount of water used shall be that required to give optimum moisture content. A portion of the required water may be added to the aggregate prior to the addition of the cement, if approved. Moisture content of the material delivered to the grade shall be checked for moisture content a minimum of four times per shift using AASHTO T-217. Batch adjustments shall be made as necessary to correct for deficiencies.

After spreading, the cement treated base shall be compacted to a density of at least 95 percent of the maximum density as determined by ~~AASHTO T-134, T-191, T-217 or ASTM D-558, D-2922, D-3017~~the mix design. Density testing shall be performed using ~~either AASHTO T-191 or~~ ASTM D-2922 and D-3017.

Compressive strength of the cement treated base material shall be tested a minimum of twice per shift using Arizona ~~test method~~ARIZ 241. Strength specimens shall be compacted on site and protected from moisture loss or disturbance by any practical means. Specimens shall be kept in this manner on site for 18-24 hours inside a hard outer shelled container that will protect the specimens from external environmental elements. The specimens shall be carefully transported to the laboratory for moist curing after this initial 18-24 hour cure.

After compaction, the surface of the cement treated base course shall not deviate at any point more than 3/8 inch from the lower edge of a 10-foot straightedge laid parallel to the centerline of the roadway.

A construction joint shall be made at the end of each day's construction by trimming the end of the compacted mixture to a straight vertical plane, normal to the centerline of the roadway and with the vertical edge in thoroughly compacted material.

Cement shall not be added to more material than will be mixed, compacted and sealed the same day. Cement treated base shall not be mixed or placed when either the aggregate or subgrade is frozen. The air temperature shall be at least 40°F. in the shade and rising at the time of mixing.

In areas which are inaccessible to the mixing, spreading or compacting equipment designated herein, other methods and equipment acceptable to the Engineer may be utilized.

The mixed material shall not remain undisturbed on the subgrade for more than 30 minutes and not more than 3 hours shall elapse between the time water is added to the mixture and final compaction is accomplished.

The mixed materials shall be spread for the full width of the base under construction, either by one spreader or by several spreaders operating in a staggered position across the subgrade, unless permission is granted to do part-width construction. Should permission be granted for part-width construction, not more than 30 minutes shall elapse between the times of placing the material in adjacent lanes at any location, and the longitudinal joint against which additional mixed material is to be placed shall be trimmed to a straight vertical plane parallel to the centerline of the roadway. Trimming shall be done in such a manner as to cause the least possible loosening of the compacted base material and to leave no loose material on the subgrade. The material cut away in trimming may be used in the construction of the shoulders or the adjacent lanes if approved, or shall be disposed of in a satisfactory manner.

During mixing, spreading and compacting and until the application of the curing seal, any moisture lost by evaporation shall be replaced by the addition of water by means of a light fog or fine spray.

The mixed base materials shall be covered as soon as possible after final compaction and shall be cured in accordance with this specification.

312.4 TRAVELING PLANT MIXING:

312.4.1 Placing Aggregate: The aggregate to be treated shall be placed on the roadway either as a uniform layer which, when compacted, will produce a base of the depth and width shown on the plans or as one or more windrows which, when spread, will yield a uniform layer which will compact to the prescribed dimensions. If the aggregate is placed in one or more windrows, a windrow sizer will be required. The number and size of the windrows may vary, depending on the width and depth of treatment and on the capacity of the machine, but regardless of size, the windrow shall be uniform in cross-section and shall not be larger than can be handled by the plant.

Care shall be exercised during the placement of the aggregate to prevent segregation of the fine and coarse portion of the aggregate.

312.4.2 Placing Cement: Cement shall be added to the uniform layer or windrow of aggregate by means of mechanized equipment which will spread the cement in correct and uniform quantities. For any section of roadway, the quantity of cement placed by mechanical spreaders shall not deviate more than 10 percent from the computed quantity for the section. When cement is applied to a windrow, the top of the windrow shall be slightly trenched to retain the spread of cement.

If storm winds cause a loss of spread cement, spreading operations shall be halted until such winds subside and, at the first indication of losses, prompt action shall be taken to avoid further losses. If cement losses are deemed excessive, the deficient quantity shall be furnished and added in the proper amount by the Contractor at no additional cost to the Contracting Agency.

312.4.3 Mixing: Mixing shall be accomplished by means of an approved single pass traveling continuous mixing machine, or combination of machines, of the pug or auger type. The machine shall be so constructed that the device for picking up or mixing the aggregate can be controlled and during the mixing operations it shall be set to mix the aggregate, cement and water to the design depth without cutting into or disturbing the subgrade or picking up any material other than that material to be processed. The machine shall be equipped so that water may be introduced at the time of mixing through a metering device which will accurately and uniformly control and measure the amount of water being used.

The cement and aggregate shall be mixed in the machine simultaneously with the adding, through the machine, of the additional amount of water required.

The material shall be spread immediately after mixing, in reasonably close conformity to the lines, grades and dimensions established or shown on the plans.

312.4.4 Stationary Plant Mixing: If the stationary plant method of mixing is employed, the aggregate, cement and water shall be mixed at a central plant using either a batch pug mill type or a continuous type mixer. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected, either by a reduction in the weight of materials or by other adjustments.

312.4.5 Batch Mixing: If a batch pug mill type mixer is used, the aggregate and cement shall be proportioned by batch weights. Cement shall be weighed on separate scales from the aggregate batching scales.

The weight of the charge in a batch mixer shall not exceed that which will permit complete mixing of all materials. The period of mixing shall not be less than 30 seconds from the time all materials are in the mixer. Water may be proportioned by volume or by weight.

312.4.6 Continuous Mixing: If a continuous type mixer is used, the materials shall be proportioned by volume.

The continuous type mixer shall be equipped with metering devices and feeders which will introduce the cement, aggregate and water into the mixer in the specified proportions. The water pump shall be equipped with a means of varying the rate of delivery. The metering devices and feeders shall be interlocked and so synchronized as to maintain a constant ratio of cement and water to the aggregate.

The rate of feed to a continuous type mixer shall not exceed that which will permit complete mixing of all the material.

312.4.7 Spreading: The treated material shall be transported from the plant to the prepared subgrade in approved equipment.

The surface on which the material is to be placed shall be thoroughly moistened and kept moist, but not excessively wet, until covered by the material.

Plant mixed cement treated base shall be spread by approved spreader boxes or finishing machines. The machines shall be constructed and operated so as to produce a layer of uniform density and cross-section an in sufficient quantity to provide a compacted base reasonably conforming to the lines, grades and cross-sections established or shown on the plans.

312.4.8 Compacting: Initial compaction shall begin immediately after mixing and spreading. Successive passes of compacting equipment shall overlap the previous adjacent pass by at least 25 percent of its width. Following initial compaction and before final compaction, the treated material shall be bladed with a motor grader or a Planning machine to obtain a surface reasonably true to the lines, grades and cross-sections established or shown on the plans. During and immediately following the shaping operations, if required, the Contractor shall lightly scarify the surface with a nail drag or other approved equipment to prevent the formation of surface compaction planes.

Extreme care shall be exercised by the Contractor during the blading operation so that no more material than is necessary is disturbed and so that this operation can be completed as quickly as possible. Material thus cut shall be wasted if so directed. Compaction shall proceed without interruption, except as stated above, until the required degree of compaction is obtained.

312.5 INVERTED SECTION:

Where the cement treated base is to be covered with an aggregate base material to prevent shrinkage crack reflection and overloading of the cement treated base, the minimum thickness of the aggregate base shall be 4 inches, unless otherwise specified in the special provisions. In order to provide for free internal drainage of the aggregate base course overlaying the cement treated material, it shall be non-plastic and the percentage of material passing the No. 200 sieve shall not exceed 8. The cement treatment shall be held back approximately 1 foot from each curb line so

as to permit drainage of any water that may become trapped between the cement treated base material and the bituminous surfacing.

312.6 CURING:

The mixed cement treated base materials shall be covered as soon as possible after final compaction with a bituminous curing seal. Application shall be by means of a pressure distributor in accordance with the requirements of Section 330. The approximate quantity of bituminous material to be used shall be as specified; however, the exact amount will be determined by the Engineer at the time of application.

After the bituminous curing seal has been applied, the cement treated base course shall be kept free of equipment and traffic for a period of at least 7 days or until it will not pick up under traffic. Curing seal shall conform to the requirement of Section 712 or 713 for the type specified.

In lieu of the curing seal, the Contractor may, at his option, keep the surface of the compacted base continuously moist until overlaid with the aggregate base course. The aggregate base or the surfacing, may be placed as soon as the cement treated base has been compacted. The spray equipment on the water truck shall be approved by the Engineer prior to the use of this equipment to spray the soil cement base course. The spray equipment must produce a fine, even spray to prevent washing of the surface of the base course. A cement treated section may be opened to all traffic immediately after placement and compaction of the surfacing.

312.7 DEFICIENCY:

When, in the opinion of the Engineer, there is reason to believe that a deficiency in thickness exists in the cement treated base, cores will be taken in the same pattern as that defined in Section 321. If the base has been covered or it is otherwise impractical to correct the deficiency of ½ inch or more in thickness, the corrective measure listed in Table 310-1 for Type II deficiency shall be taken by the Contractor at no additional cost to the Contracting Agency.

312.8 PAYMENT:

Payment for the portland cement will be made by the tons of cement complete in place.

Payment for base material will be made by the tons of aggregate complete in place including mixing, spreading, and compacting.

No separate payment will be made for curing.

SECTION 705

PORTLAND CEMENT TREATED BASE

705.1 GENERAL:

The cement treated base shall consist of aggregate, cement, and water. Use of other types of materials must be approved by the Engineer. ~~of furnishing all materials in accordance with these specifications. The estimated cement requirement is 3 ½ percent by weight of the dry aggregate~~The cement content shall be sufficient to yield ~~compressive strength of 500 psi plus one percent overdesign after 7 days of curing.~~ . The compressive strength requirement shall be determined by the project specifications. The amount of cement used in the mix design shall be determined by the project specifications.~~The cement shall be Type II, low alkali.~~

705.2 AGGREGATE FOR CEMENT TREATED BASE:

The aggregate for cement treated base shall conform to the requirements of Section 702-2 Aggregate Base Course. ~~701 except the plasticity of the material passing the No. 40 sieve shall not exceed 5 and the grading shall be per Table 705-1.~~

~~**TABLE 705-1**~~	
~~**CEMENT TREATED BASE GRADATION**~~	
~~**Sieve Size**~~	~~**Percentage By Weight Passing Screen**~~
~~1 ½ inches~~	~~100~~
~~No. 4~~	~~40-70~~
~~No. 40~~	~~30 Max.~~
~~No. 200~~	~~38000~~

Comment [DR10]: Table to be re-written by Mike Whitman.

705.3 PORTLAND CEMENT AND WATER:

Portland cement and water shall conform to the requirements of Section 725.

705.4 ~~COMPRESSIVE STRENGTH OF CEMENT TREATED BASE~~ CEMENT TREATED BASE MIX DESIGN:

~~The minimum compressive strength at 7 days shall not be less than 500 psi when tested in accordance with ASTM D-1633.~~A cement treated base mix design incorporating the proposed materials shall be completed prior to the start of work. ~~—~~The mix design shall be performed in accordance with Arizona Department of Transportation test methods ARIZ-220, ARIZ-221, and ARIZ-222. Compressive strength specimens shall be tested in accordance with ARIZ~~riz~~ 241. The final report shall include the following elements: ~~at minimum:~~

1. The source and supplier of the aggregate ~~as well as the virgin aggregate~~ including gradation and plasticity index testing.
2. The source, supplier, and type of cement.
3. The cement content required to meet the project specifications. ~~500 psi plus one percent overdesign strength after 7 days of curing as per Ariz 220.~~ Cement content shall be calculated by the dry weight of the combined aggregate-cement mixture.
4. The optimum moisture and maximum dry density of the proposed blend at the target cement content as determined by Arizona test method 221.

5. The rock corrected optimum moisture and maximum dry density of the proposed blend at the target cement content as determined by Arizona test method 222.
6. A summary of design compressive strength testing including a graph plotting cement content as the x-axis and compressive strength as the y-axis.

~~**705.5 BITUMINOUS MATERIAL FOR CURING SEAL:**~~

~~Bituminous material for curing seal shall conform to the requirements of Sections 712 or 713 for the type specified.~~

SECTION 705

PORTLAND CEMENT TREATED BASE

705.1 GENERAL:

The cement treated base shall consist of aggregate, cement, and water. Use of other types of materials must be approved by the Engineer. The compressive strength requirement shall be determined by the project specifications. The amount of cement used in the mix design shall be determined by the project specifications.

705.2 AGGREGATE FOR CEMENT TREATED BASE:

The aggregate for cement treated base shall conform to the requirements of Section 702-2 Aggregate Base Course.

705.3 PORTLAND CEMENT AND WATER:

Portland cement and water shall conform to the requirements of Section 725.

705.4 CEMENT TREATED BASE MIX DESIGN:

A cement treated base mix design incorporating the proposed materials shall be completed prior to the start of work. The mix design shall be performed in accordance with Arizona Department of Transportation test methods ARIZ-220, ARIZ221, and ARIZ-222. Compressive strength specimens shall be tested in accordance with ARIZ 241. The final report shall include the following elements:

1. The source and supplier of the aggregate including gradation and plasticity index testing.
2. The source, supplier, and type of cement.
3. The cement content required to meet the project specifications. Cement content shall be calculated by the dry weight of the combined aggregate-cement mixture.
4. The optimum moisture and maximum dry density of the proposed blend at the target cement content as determined by Arizona test method 221.
5. The rock corrected optimum moisture and maximum dry density of the proposed blend at the target cement content as determined by Arizona test method 222.
6. A summary of design compressive strength testing including a graph plotting cement content as the x-axis and compressive strength as the y-axis.

SECTION 623

SPECIAL BEDDING FOR MAINLINE STORM DRAIN PIPE
Adding in entirety

The Contractor **shall** utilize a commercial-source ~~cement-enriched slurry aggregate base course~~ ½-sack cement CLSM in accordance with MAG Section 728 as bedding from the outside bottom of the pipe to the springline of the pipe for all mainline storm drain pipe, except cast-in-place pipe. ~~The slurry aggregate base course shall be per MAG Specification Section 728. The slurry shall have a minimum 8-inch slump, and a minimum of 25 psi compressive strength and a maximum of 100 psi based on a 28 day test. Cement slurry aggregate base course~~ CLSM bedding is not required for catch basin connector pipes.

~~Only commercial source cement-enriched slurry ABC will be allowed. Batch mixing of slurry on site by the Contractor will not be allowed.~~ The Contractor shall submit the commercial source mix design ~~for cement-enriched slurry ABC~~ at the pre-construction meeting, along with all other required commercial mix designs. CLSM

The Contractor, **at his option**, may excavate a trench having a cross-section with a rounded bottom rather than a flat bottom. If this option is chosen, the trench cross-section must maintain a minimum of 6-inches between the outside wall of the pipe and the trench wall. The minimum trench width at the springline for each side of the pipe, as specified in Section 601, may be reduced to 6-inches for all pipe sizes if this option is used.

The Contractor, **at his option**, may use ~~cement-enriched slurry aggregate base course~~ ½-sack cement CLSM for the bedding material ~~specified in the City of Phoenix Supplement to MAG Section 601.3.2~~ **from the springline to one (1) foot over the outside top of pipe**.

If the Contractor elects to use corrugated steel (CSP) or high density polyethylene (HDPE) storm drain pipe, the Contractor shall use ~~cement-enriched slurry aggregate base course~~ ½-sack cement CLSM material for the entire pipe bedding, to one (1) foot over the outside top of pipe ~~no option.~~

There will be no separate measurement or payment for ~~special cement-enriched slurry aggregate base course~~ CLSM bedding. The cost shall be considered incidental to the cost of the pipe.

September 5, 2011

Re: Flowable Fill as a Backfill Material

Member of MAG Committee:

This letter addresses flowable fill versus granular fill as a backfill material for high density polyethylene pipe (HDPE). ADS pipe (and most other manufacturer's HDPE pipe) is designed per AASHTO Section 12 Load Resistance Factor Design (LRFD). This design is based on an equation that substantially increases the applied loads using safety factors and load modifiers while reducing the resistance. The design equation is also derived from material properties such as tensile strength and modulus of elasticity.

AASHTO Section 12 uses granular fill as a basis for design. The chapter lists the material properties used in design, and the secant constrained soil modulus for different soil types and compaction efforts. The end result is a standard for polyethylene pipe that has a minimum 50-year design service life. Florida and Pennsylvania Department of Transportation, both have granted a 100 year design service life for HDPE pipe. AASHTO Section 12 does not address or endorse the use of flowable fill for installation.

Mandating the use of flowable fill as a backfill material for polyethylene pipe increases the overall cost of installation and has no added value to the service life of the product.

Sincerely,

Peggy Graham

Peggy B Graham, P.E., CFM
Regional Engineer- Product Manager
Advanced Drainage Systems, Inc.

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September 22, 2011

Maricopa Association of Governments
Standard Specifications & Details Committee

Re: Case 11-21 – Incorporation of PHX Supplement Section 623

Dear Committee Member,

I am writing this letter in regards to Case 11-21 for the inclusion of the City of Phoenix requirements for CLSM backfill into the MAG specifications. I have great concern for this proposed change as it will undoubtedly result in significant project cost increases, installation complications, slowed pipe installation rates, and a greater challenge for MAG's finished pipe installation requirements to be met and provide virtually no additional value with respect to installed performance or service life.

Use of CLSM as pipe backfill results in a much more difficult installation practice as special precautions are necessary to reduce pipe buoyancy forces. This typically necessitates pipe anchoring or the use of temporary ballast and requires the application of CLSM in lifts. Further, each lift must be allowed to set-up before the next lift is applied. These precautions must be carefully executed, or pipe alignment and grade may easily fluctuate beyond the permissible variance. All of these issues typically result in reduced pipe installation rates, increased construction costs, and greater likelihood for installed pipe issues.

The final strength of CLSM is typically equal-to or less-than that of a compacted structural fill material, especially when considering the current backfill materials required in Section 603 of the MAG specification. Additionally, HDPE pipe has a strong successful performance record when installed with standard backfill. While HDPE pipe is successfully backfilled with granular fill across the country, there are countless successful examples within Arizona, and more specifically the Maricopa area. This level of success is further bolstered by the existence of the *AASHTO LRFD Section 12: Buried Structures and Tunnel Liner* design methodology. LRFD Section 12 is the design method used for installed HDPE pipe systems, along with other pipe materials, and incorporates several safety and load factors to accommodate variances in installation quality resulting in an extremely conservative analysis tool.

While CLSM may certainly have a place in unique pipe applications requiring its specific attributes, CLSM is not the most appropriate material for use in general pipe installations as it has significant negative cost, installation, and performance implications with very little benefit. I recommend continued use of the current MAG backfill specification based on the successful track record and supporting AASHTO LRFD design method.

I ask for your consideration on this matter and your support against the implementation of CLSM backfill as a requirement for pipe installation.

Very Truly Yours,

Carl Douglass, P.E.
Director of Engineering
Prinsco, Inc.

CORPORATE HEADQUARTERS: 1717 16th Street NE | 3rd Floor | Willmar, MN 56201
LOCATIONS: Fairfax, MN | Prinsburg, MN | Rose Creek, MN | Chatsworth, IL | Fort Dodge, IA | Jesup, IA | Bethany, MO | Fresno, CA

Water/Sewer Working Group Meeting

Meeting Notes
September 20, 2011

Opening:
A meeting of the Specifications and Details Water/Sewer Working Group was called to order by chair Jim Badowich on September 20, 2011 at 1:35 p.m. in the MAG Agave Room.

1. Participants
Jim Badowich (Avondale), Rita Chihanik (Neenah), Jami Erickson (Phoenix), Peter Kandaris (SRP), Paul Nebeker (Pipe Right Now), Matt Savage (Ferguson), Craig Sharp (W. C. Scoutten), Gordon Tyus (MAG), Scott Zipprich (Buckeye)

2. Manhole Spec and Detail Updates
Mr. Badowich asked Mr. Sharp if he had researched specifications of precast bases used in California. Mr. Sharp said he has some details that they are modifying. Although they didn't have written specifications, the details refer to ASTM specs. Mr. Zipprich said the local pre-caster Jensen and Olson have been more reluctant to the changes. They are hoping that Old Castle may help break the mold. He said he wants a flexible joint for clay pipe, however currently they are dry cast and cored leaving exposed rebar. Mr. Zipprich said he doesn't want the exposed steel, and wants a sound design before proposing it to the committee. He suspects that resistance from local manufacturers may be because they currently do more work by doing the cast in place bases.

Advantages of the precast base included quicker installation and holding just one party (the contractor) responsible. There was also discussion about the trench length getting more restrictive (Maricopa County is down to 600 feet.) It was agreed that the precast base would remain an option, and may need to outline the options and requirements in written specifications. Mr. Zipprich also discussed methods of installing manholes over existing pipe.

Jim Badowich said the manhole details, such as 420, need to be updated to get rid of the brick and steps, and reinforce the base. Members agreed that for manholes 12'-20' deep steel should be added (for example #4 @ 12" on center). For manholes 20' or deeper the manhole should be designed by an engineer. Peter Kandaris said the concrete used for cast-in-place bases should be considered structural, and use MAG 'A' with a cure time of 7 days. Since the bases typically are not allowed that long to cure, the engineer should specify what mix should be used to allow less cure time such as accelerator, more concrete, high-early, etc. in order to get performance requirements necessary. He said the group should also work with the Materials Working Group to update specs for the testing of AB.

3. Manhole Frames and Covers (Case 11-13)
Rita Chihanik brought in revised details of the manhole frames and covers. At the committee meeting it was recommended to keep the current frame thickness rather than the thinner version proposed at the previous working group meeting. Mr. Zipprich discussed what minimum thickness were needed for the 24" and 30" frames and covers, and also asked Ms. Chihanik to check on the minimum weights of the frames and covers. She said that the current MAG detail

drawings are based on class 30 cast iron rather than class 35, which everyone is using. Local suppliers include Nenah, Deter, East Jordan and South Bay. Mr. Tyus suggested that in order for the committee to feel comfortable with the changes, the details should match the product agencies have been receiving. Mr. Zipprich described changes needed to the details including deleting some dimensions, adding minimum thickness, and adjusting the note. He also suggested adding a detail to show the raised circles and/or bumps. Ms. Chihanik will work on modifying the detail drawings and send them to Mr. Zipprich, Mr. Badowich and Mr. Tyus for review, with the goal of having the final version ready for the next agenda packet that will be mailed out on next Wednesday.

4. Wet Barrel Fire Hydrant Spec and Detail Update

This is currently Case 11-14 at the committee. Paul Nebeker introduced Matt Savage of Ferguson, who passed out information on Gradelocks, a type of offset that makes it easier to adjust and make the connection of the water line to the fire hydrants. He explained that the connections are restrained. Mr. Sharp agreed to include this as an option on the revised hydrant details they are working on. Ms. Erickson asked for a copy of the latest detail so they can forward it to their fire department. She also asked if bollards could be added since Phoenix has a supplement for it.

5. Other Water/Sewer Cases

Jami Erickson said she was approached by fiberglass pipe manufacturers to sponsor a case to add it to MAG, but that Phoenix was unwilling to do so based on some prior experiences with the material. The flexibility of fiberglass pipe was discussed, as well as grouting it in place. Phoenix used a slurry seal around it similar to Syd Anderson's Case 11-21: Special Bedding Mainline Storm Sewer Pipe. Mr. Kandaris said he was interested in industry's opposition to this (Case 11-21) proposal.

6. Specs and Details Detectable Warnings Revisions (Case 11-19)

Peter Kandaris updated the detectable warnings section to include ADA related language, and remove concrete-specific performance information. The thought was to make the ADA changes first, while still allowing the agencies to specify the type of material they wished to use. A new case with performance specifications for alternate materials could be proposed in the future.

7. Next Meeting Date

Members agreed to meet again on Tuesday, October 18th at 1:30 at the MAG office. Mr. Tyus said he would try to again reserve the Agave room.