

February 24, 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, March 2, 2011 at 1:30 p.m.  
MAG Office, Suite 200 (Second Floor), Cholla 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.

Please park in the garage under the building, bring your ticket, parking will be validated. For those using transit, Valley Metro/RPTA will provide transit tickets for your trip. For those using bicycles, please lock your bicycle in the bike rack in the garage.

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. 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**  
**March 2, 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.

3. Approval of February 2, 2011, Meeting Minutes

**Review of 2010 and 2011 Cases**

4. Case 10-05:

Revise FOREWARD to clarify use of the MAG Specifications and Details for Public Works Construction document. See Item 4.

5. Case 10-08:

Re-write Section 717 ASPHALT-RUBBER. See item 5.

6. Case 10-12:

New Section 361 – Shallow Depth Fiber Optic Micro-Conduit Installation.

7. Case 11-01: Miscellaneous Corrections

- A. Correct typographical errors in Table 711-1.
- B. Correct typographical error in Table 705-1.
- C. Potential new correction cases.

2. Information.

3. Review and approve minutes of the February 2, 2011 meeting.

4. Information and discussion.

Sponsor: Jesse Gonzales, Peoria

5. Information and discussion.

Sponsor: Bob Herz, Maricopa County

6. Information and discussion.

Sponsor: Rod Ramos, Scottsdale

7. Information and discussion.

Sponsors: Bob Herz, Maricopa County and Peter Kandaris, SRP

8. Case 11-02:  
 Add an Asphalt Pavement Safety Edge option to Detail 201.

9. Case 11-03:  
 Replace cadmium plated bolts referenced in Section 610.13 with zinc plated bolts as described in ASTM-B633. See item 9.

**New 2011 Cases**

10. Case 11-04:  
 Replace reference to MAG Detail 190 in MAG Section 301 with ASTM D4718. Delete MAG 190. See item 10.

11. Case 11-05:  
 Move MAG Section 225 Water Requirements into MAG Section 104.1.3. See item 11.

12. Case 11-06:  
 Remove sections of the MAG specifications that are no longer used or refer to outdated technologies. See item 12.

13. Proposed New Cases  
 Members can present new cases for information and discussion.

14. Potential Cases  
 Members can discuss other potential new cases which they are working on, or are planning to present at a future meeting.

**General Discussion**

15. Working Group Reports  
 A. Outside Right-of-Way Working Group Report on 2/22/2011 meeting.  
 B. Other working groups

8. Information and discussion.  
 Sponsor: Bob Herz, Maricopa County

9. Information and discussion.  
 Sponsor: Jesse Gonzales, Peoria

10. Information and discussion.  
 Sponsor: Peter Kandarlis, SRP

11. Information and discussion.  
 Sponsor: Peter Kandarlis, SRP

12. Information and discussion.  
 Sponsor: Scott Zipprich, Buckeye

13. Information and discussion.

14. Information and discussion.

15. Information and discussion.  
 Outside ROW Chair: Peter Kandarlis, SRP

- |   |                                 |
|---|---------------------------------|
| 16. <u>Staff Reports</u><br><br>Update from staff as needed.  | 16. Information and discussion. |
| 17. <u>Open General Discussion</u><br><br>Members can report on any items of interest to the committee. See item 17.  | 17. Information and discussion. |
| 18. <u>Request for Future Agenda Items</u><br><br>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. | 18. Information and discussion. |

Adjournment

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

February 2, 2011

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

AGENCY MEMBERS

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

ADVISORY MEMBERS

John Ashley, ACA	* Jeff Hearne, ARPA
Jeff Benedict, AGC	Peter Kandararis, SRP
Tony Braun, NUCA	Paul R. Nebeker, Independent
* Kwigs Bowen, NUCA	Mike Smith, ARPA
Brian Gallimore, AGC	

MAG ADMINISTRATIVE STAFF

Gordon Tyus

\* Members not attending or represented by proxy.

GUESTS/VISITORS

Arturo Chavarria, Hanson Pipe  
Jimmy Freeman, Industrial Threaded Products  
Wally Gross, Industrial Threaded Products  
Dan Hernandez, Quanta Services  
Matt Johnson, Synergistic  
Michael Hook, American Concrete Pipe Association  
Jerre Mills, Sunbelts Asphalt

1. Call to Order

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

2. Call to the Audience

Mr. Tobiasson asked audience members to introduce themselves and gave members of the public up to three minutes to address the committee.

Matt Johnson introduced himself, gave some background of his work history in the industry, and briefly explained a software database system he was developing. The system would allow users to quickly find MAG specifications and details as well as link to agency supplements. He said this service was designed to help contractors. He also volunteered to give demonstrations to members and allow agencies to try the software and give feedback for its development.

Wally Gross of Industrial Threaded Products introduced himself and described problems with Section 610.13, regarding the requirement to use cadmium plating on bolts. He explained the specification was out of date, and that zinc plating had replaced cadmium in most applications because cadmium is toxic and a more expensive material. He explained zinc plating had the same corrosion resistance and was specified in ASTM-B633. Jesse Gonzales mentioned that he has a paper from OSHA he can share on the hazardous properties of cadmium. Mr. Gross volunteered to present to the committee for their consideration, information and draft revisions that he prepared. Mr. Gonzales agreed review the materials and sponsor a case to update Section 610.13.

Jerre Mills introduced himself and described a hot-in-place asphalt recycling process to repair utility cuts and make patches. He described a process using radiant heat that could penetrate 3"-4" of the pavement surface, and a type of emulsion that would seal it to make a contiguous patch. He said that Phoenix and Peoria have used this process in the past.

Other guests that introduced themselves were Jimmy Freeman, Dan Hernandez, and Mike Hook.

3. Approval of Minutes

The members reviewed the January 5, 2011 meeting minutes. Jesse Gonzales introduced a motion to accept the minutes as written. Bob Herz seconded the motion. A voice vote of all ayes and no nays was recorded.

## Review of 2010 and 2011 Cases

### 4. Case 10-05 – Revise FOREWORD

*Clarify use of the MAG Specifications and Details for Public Works document.* Jesse Gonzales said that no changes were made since the last meeting. He says he has a few more changes he would like to make and submit at a future meeting.

### 5. Case 10-08 – Revise Section 717 Asphalt Rubber

*Revise Section 717 ASPHALT-RUBBER to obtain a uniform specification.* Bob Herz said that no changes were made since the last meeting. He said he needed to coordinate both internally and with external agencies to make additional revisions. Mike Samer said that Mesa had reviewed the section and was okay with most of it, although he did have some questions, including why the percentage of ground rubber was a maximum of 22 percent rather than 25 percent. Mr. Herz said MCDOT had some changes to their supplement of Section 717 that he wanted to update and review it internally, as well as incorporate information from Phoenix.

### 6. Case 10-12 – New Section 361 – Shallow Depth Fiber Optic Micro-Conduit Installation

*Provide specifications for the installation of underground fiber optic micro-conduit telecommunications facilities within the public right-of-way.* The case sponsor, Rod Ramos, apologized for not being present at the last meeting, but said he did appreciate the comments provided by Dan Hernandez in his absence. He said Scottsdale wants to do a demo repairing cracks in various types of streets. Mr. Hernandez said his company has gone to two separate locations and plans to follow-up with Scottsdale staff to schedule the demonstrations. He also said the written materials he provided (*see case packet*) included updated specifications and details, which also addressed the issue of using a special grout rather than sand slurry.

Mr. Ramos had nothing new at this time but was looking forward to testing the process for crack sealing applications. He also mentioned Scottsdale was testing a coating to counteract the heat island effect, and using it for crack repair as well. He went on to explain that this case raises two major policy issues. One is the issue regarding the shallow burial of conduit which is in conflict with the current specifications. Another is how to repair the conduit if it is cut, and who would be responsible for the repair. There was also some discussion about where the conduit would be located—if it was as located as shown in the detail, one foot from the curb, or down the center of the street

Mr. Gonzales asked Mr. Hernandez if the use of the micro-conduit was being pushed due to location of cell towers and related issues. He responded that telecommunications companies want to use this process to install new fiber, especially in more isolated areas, or rocky areas where it is difficult to dig. He also said it was used by Caltrans for Intelligent Transportation Systems (ITS) projects.

Warren White asked how it is allowed in the right-of-way. Dan Hernandez said they get permits from the agency and permission of owners when outside the ROW. Scott Zipprich noted that this specification would not replace the trench specifications, and should be an option only in special situations. He also brought up franchise issues for companies with existing fiber in the right-of-way. Tom Kaczmarowski mentioned contract and licensing agreements would need to be considered as well.

Mr. Ramos said the companies initially wanted to use this process everywhere. He said Scottsdale has used it with shared fiber for an ITS project. Scottsdale also approved a recent project because it was used on a private road in a rocky area. Members discussed several issues including what expectations there would be if the fiber was sold, if it was broken during road work, how it was repaired, where the boxes would be, the distances between cable pulls, and other specific issues. Mr. Hernandez explained the fiber is blown in rather than pulled, can go up to 5,000 feet, and the boxes are moved into curb area.

Jim Badowich suggested that if this process was allowed, it may become the norm. Mr. Ramos said the intent was to create a specification and detail that could be used for special circumstances. This process was tested in Canada is used extensively in Europe. He explained this may be an alternative where you can't dig and boring is too difficult.

John Ashley said the conduit should be placed beneath the paving surface because the expansion and contraction of the pavement could force it to the surface. Mr. Ashley also commented on the need for a crack sealing specification for applications in addition to the process used to seal the micro-conduit. Members agreed that a general crack sealing specification is needed. There were also questions on whether the shallow depth of the fiber was allowed under the National Electric Code. Peter Kandaris said the code did allow exceptions depending upon materials and surfaces.

Tom Wilhite asked about traffic control—what was needed, how long in use, etc. Mr. Hernandez explained that during installation typically one lane of traffic was closed, but that it required no plates, produced less dust, didn't use water, and typically could be completed in a day and reopened to traffic.

Mr. Ramos said he was looking forward to testing the suitability of the process for sealing cracks in different materials, and that he would report results back to the committee.

7. 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. No new correction cases were introduced.

## 8. Case 11-02 – Safety Edge Detail

*Add an Asphalt Pavement Safety Edge option to Detail 201.* Bob Herz said there were no changes this month, but he intends to incorporate updates in the future. Jeff Benedict discussed the difficulty of getting good compaction on the sloped safety edge, and how the rollers could push asphalt to the edge. Mr. Herz questioned how much compaction was required, and suggested using two paving layers – making the second layer a little shorter. There were questions on its use on roads without shoulders. Mr. Herz explained that the safety edge is promoted by the FHWA because it makes it easier for drivers to get back onto the pavement without overcorrecting. He referenced links to materials on the FHWA website for more information. He said MCDOT had lawsuits in the past relating to this issue, and the safety edge could help from a standpoint of public safety. Mr. Herz said he wanted to make updates concerning the edge compaction requirements, address edge erosion issues, as well as update the title of the detail.

## 9. Proposed New Cases:

Case 11-03 – Replace Cadmium Plated Bolts. *Replace cadmium plated bolts referenced in Section 610.13 with zinc plated bolts as described in ASTM-B633.* Jesse Gonzales agreed to sponsor this case. He said he would scan and distribute the information presented earlier by Wally Gross of Industrial Threaded Products for further discussion by the committee. Jami Ericson said she wanted to make sure the zinc plating was comparable, and also proposed the use of stainless steel plated bolts. It was noted that stainless steel can “weld” itself together. Paul Nebeker said unless the job was recently completed any maintenance would require that the effected section be cut out and replaced rather than disassembled.

## 10. Possible Future Cases

Tom Wilhite suggested changes to the pothole detail to specify something to seal the overcut. As previously mentioned, he said MAG needs a crack fill specification, with applicable material specifications for various crack fill methods. Peter Kandarlis said SRP has a crack fill specification as a Section 337. He also suggested this may be something the Asphalt Working Group may want to review.

Peter Kandarlis said the review process conducted by the Outside the Right-of-Way Working Group had identified a list of possible cases for MAG specifications and details that needed to be updated. The handouts divided the list of possible cases to those that could be deleted, those assigned to various working groups for further study, and miscellaneous issues that would require individual members and the main committee to address.

One suggestion was to provide all the potential deletions together in one case with the rationale on why it should be removed. Members could then comment on any specifications or details they use and feel should be kept, and if so what updates would need to be made to

them. It was also clarified that some of the deletions from the MAG specs were actually just moving it to the Outside ROW book. Some members described how the safety curb was used in older parts of downtown areas, and should remain as an option in the MAG book.

Chair Tobiasson assigned these potential cases to be reviewed by the working groups as noted in the agenda item below.

## 11. Working Group Reports

### a. **Water/Sewer Issues Working Group**

Chair Tobiasson asked Jim Badowich to provide an update to the Water/Sewer Issues Working Group. Mr. Badowich said that he would need to change the day of the week of the meeting from Tuesday to more likely a Wednesday. He asked if a meeting room was available at MAG. Mr. Tyus responded that usually a room is available for small groups and he would work with him to schedule a time and meeting place, as well provide a list of past attendees. Mr. Badowich said the group could help prioritize the list and begin working on the highest priorities of the cases identified by the Outside ROW Working Group.

### b. **Concrete Working Group**

Mr. Tobiasson said Jeff Herne was unable to attend today's meeting, but that the Concrete Working Group could also begin meeting again. Michael Smith agreed to help. Jesse Gonzales mentioned pervious concrete as a potential topic.

### c. **Asphalt Working Group**

Mr. Tobiasson asked Jeff Benedict if he would be willing to lead the Asphalt Working Group again. He agreed and said he would be working with other AGC members.

### d. **Materials Working Group**

Brian Gallimore said AGC has technical committees that are already working on some of these issues, and that they often invite agency members to participate. Mr. Tobiasson suggested they review items listed under the "Materials Working Group" section of the handout Mr. Kandaris provided, and asked Mr. Gallimore to head this new working group.

### e. **Specifications and Details Agency Supplement Inventory Working Group**

John Ashley noticed that many of the potential cases and supplements that were brought up have also been previously identified by the agency supplement study and working group. He said he still had a list he could present based on the group's previous work. Warren White said Chandler is moving to reduce their list of supplements, and have a goal and process to do so during their normal review. Members asked for him to share Chandler's process so that other agencies could reduce supplements and avoid new ones whenever possible. Scott Zipprich said the process of reviewing these cases can help eliminate supplements by making minor changes when needed, and many of the agency supplements may be appropriate to be included in Outside Right-of-Way document.

f. **Specifications and Details Outside the Right-of-Way Working Group**

Peter Kandaris reported that at the January 25 meeting, the group helped identify how the potential MAG cases could be presented to the committee. This was shown on the *Case Actions Recommended* handout provided. The committee suggested pros and cons on possible ways of publishing the outside ROW specs including making it a supplement, as a separate complete book or some combination. Mr. Kandaris said the next meeting would be Tuesday, February 22 at the ARPA office. The plan will be to start modifying the identified sections and details to make them appropriate for on-site construction.

12. Staff Reports

Gordon Tyus said the packet included a usage report on agency access to the ASTM website. He also said there were about 65 super-users signed up. He asked the members to continue to promote the use of the ASTM site within their agencies and with colleagues at other MAG agencies not represented on the committee. Mr. Tyus said MAG currently has this project in the next fiscal year budget, but that he would like to show that it is used by agencies to justify funding in future years.

Mr. Tyus also noted that materials for two additional potential cases were included in the packet. One was a list of ASTM standards MAG references that are no longer in use. They need to be researched to see if the new ASTM standard is appropriate, the old one simply deleted or if another specification is required.

The second issue was regarding a new law recently passed by congress that reduces the lead content in piping materials used for drinking water. The requirements will begin 36 months after the law was signed. A vendor provided Mr. Tyus information about brass fittings and other fixtures that will meet the new standard. He also described problems in California, where they have already implemented the stricter standard, but ended up with inventories that would not be used due to slow implementation. Mr. Tyus said some specifications in MAG should be updated to ensure compliance with the new law. These include Sections 631, 754 and 755 which currently reference brand names rather than performance specifications.

13. Open General Discussion

Peter Kandaris described a project by SRP using a thermal backfill material where they modified the ½ sack CLSM mix to include more fly ash. He said the mix was very successful in increasing the thermal properties 50% while the strength remained mostly unaffected. He said Gilbert will be testing it for excavatability. He said he would provide a handout on it for distribution to members.

Mr. Kandaris said he would prepare the deletions case for the next meeting.

14. Adjournment:

Chairman Tobiasson adjourned the meeting at 3:26 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 FOREWARD to clarify use of the <i>MAG Specifications and Details for Public Works Construction</i> document.	Peoria	Jesse Gonzales	03/03/2010 05/05/2010		0 0 0	Yes No Abstain
10-08	Case 10-08: Re-write Section 717 ASPHALT-RUBBER.	MCDOT	Bob Herz	05/05/2010		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 08/04/2010		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.	MCDOT SRP	Bob Herz Peter Kandarlis	01/05/2011		0 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		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	02/02/2011		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 Kandarlis	03/02/2011		0 0 0	Yes No Abstain
11-05	Case 11-05: Move MAG Section 225 Water Requirements into MAG Section 104.1.3.	OROW WG/ SRP	Peter Kandarlis	03/02/2011		0 0 0	Yes No Abstain
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		0 0 0	Yes No Abstain

## Case 10-05

A 3D, yellow and orange stamp with the text "Draft for Comment" in a bold, sans-serif font, tilted slightly upwards and to the right.

**FOREWORD (In Right of Way)**

Publication of these Uniform Standard Specifications and Details for Public Works Construction fulfills the goal of a group of agencies who joined forces in 1966 to produce such a set of documents. Subsequently, in the interest of promoting county-wide acceptance and use of these standards and details, the Maricopa Association of Governments accepted their sponsorship and the responsibility of keeping them current and viable.

These specifications and details, representing the best professional thinking of representatives of several Public Works Departments, reviewed and refined by members of the construction industry, were written to fulfill the need for uniform rules governing public works construction performed for Maricopa County and the various cities and public agencies in the county. It further fulfills the need for adequate standards by the smaller communities and agencies [within Maricopa County](#) who could not afford to promulgate such standards for themselves. [Agencies in other regions or climes within the state of Arizona wishing to apply these specifications may need to make adjustments for local conditions.](#)

[These uniform specifications and details are intended to aid the private construction industry in providing modern materials and construction techniques, eliminate conflicts and confusion, lower construction costs and encourage more competitive bidding by private contractors for the benefit of public works construction in the right-of-way. Use of these standards for projects outside of the right-of-way should be reviewed by professional engineers and architects and applied with care to insure relevance to the planned work.](#)

[Specifications and details contained herein should be incorporated into project plans and specifications after careful review by the design engineer or architect of specific project needs. Not all specifications will apply to all projects as these standards are developed to meet a variety of public works needs. Prepared plans and specifications should clearly call out specific uniform specifications and details required for the project.](#)

[Uniform specifications and details are not a substitute for good engineering judgment. Unique conditions will arise that are outside the scope of these standards. When this happens, professional engineers and architects are required to use their judgment to amend these standards to best meet site-specific project needs in accordance with rules set forth by the State of Arizona and policy statements made by the Arizona State Board of Technical Registration.](#)

The Uniform Standard Specifications and Details for Public Works Construction will be revised periodically and reprinted to reflect advanced thinking and the changing technology of the construction industry. To this end a Specifications and Details Committee has been established as a permanent organization to continually study and recommend changes to the Specifications and Details. Interested parties may address suggested changes and questions to:

Standard Specifications & Details Committee  
c/o Maricopa Association of Governments  
302 North First Avenue, Suite 300  
Phoenix, Arizona, 85003.

These suggestions will be reviewed by the committee and appropriate segments of the industry and cumulative annual revisions will be published the first of each year. A copy of this publication is available for review on the internet at the website listed below.

Please follow the links to the publications page and look for *Uniform Standard Specifications for Public Works Construction and/or Uniform Standard Details for Public Works Construction Within Public Rights of Way*:

[www.mag.maricopa.gov](http://www.mag.maricopa.gov)

While in the interest of **regional** uniformity, it is hoped that all using agencies will adopt these standards with as few changes as possible, it is recognized that because of charter requirements and for other reasons, some agencies will find it necessary to modify or supplement certain requirements. **In the interest of reducing a proliferation of agency specific modifications it is strongly recommended that the agency representatives to MAG bring their modifications for consideration by the committee for inclusion into these standards.**

CASE 10-08 (Revised 2/18/2011)

**SECTION 717**

**ASPHALT- RUBBER**

**717.1 DESCRIPTION:**

The work under this section shall consist of furnishing, proportioning and mixing all the ingredients necessary to produce asphalt-rubber material.

**717.2 MATERIALS:**

**717.2.1 Asphalt-Rubber:**

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

**Rubber:** Rubber shall meet the following gradation requirements when tested in accordance with Arizona Test Method 714.

Sieve Size	Percent Passing <u>MCDOT</u>	Percent Passing <u>Phoenix</u>
#10 (2.00 mm)	100	<u>100</u>
#16 (1.18 mm)	65 - 100	<u>75 - 100</u>
#30 (600 μm)	20 - 100	<u>25 - 60</u>
#50 (300 μm)	0 - 45	<u>0 - 20</u>
#200 (75 μm)	0 - 5	<u>0 - 5</u>

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 Comment [rth1]: What is the impact on cost if City of Phoenix stricter gradation limits are used?

The rubber shall have a specific gravity of  $1.15 \pm 0.05$ , shall contain not more than 0.5 percent fabric and shall be free of wire or other contaminating materials. 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 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.

**717.2.2 Asphalt-Rubber Proportions and Properties:** Ground rubber in asphalt-rubber shall be a minimum of 20 percent and a maximum of 22 percent by weight of the asphalt cement.

Comment [rth2]: Mesa has questioned why the maximum ground rubber is limited to 22% and not 25%. MCDOT believes that the high rubber content can contribute to raveling.

Asphalt shall be Type 1 unless otherwise specified and conform to the following:

Property	Requirement		
	Type 1	Type 2	Type 3
<b>Grade of base asphalt cement</b>	<b>PG 64-16</b>	<b>PG 58-22</b>	<b>PG 52-28</b>
Rotational Viscosity*; <del>354-350</del> °F (177°C); cps (Pascal seconds) <del>(cps)</del>	<del>1.5-4.0</del> (1500-4000) <del>(1.5-4.0)</del>	<del>1.5-4.0</del> (1500-4000) <del>(1.5-4.0)</del>	<del>1.5-4.0</del> (1500-4000) <del>(1.5-4.0)</del>
Penetration; 39.2°F (4°C), 200g, 60 sec. (ASTM D 5); <del>in (dmm)</del> (in), min	<del>10</del> (0.04) <del>(10)</del>	<del>15</del> (0.06) <del>(15)</del>	<del>25</del> (0.10) <del>(25)</del>
<del>Ductility; 39.2°F (4°C), 1cpm (ASTM D 113); cm (in), min.</del>	<del>5</del> (2)	<del>5</del> (2)	<del>5</del> (2)
Softening Point; (ASTM D 36); °F (°C), min.	135 (57)	129 (54)	126 (52)
Resilience; 77°F (25°C) (ASTM D 3407); %min	25	20	15
* The Viscometer used must be a <del>hand held rotational viscometer, such as a Rion (formerly Haake Viscometer,) Model VT – 04, or an equivalent, using Rotor No. 1, or viscometer correlated. The rotor, while in the off position, shall be completely immersed in the binder at a temperature from 350°F to 355°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.</del>			

**717.2.3 Asphalt-Rubber Design:** At least two weeks prior to the use of asphalt-rubber, the Contractor shall submit an asphalt-rubber 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.

**717.3 CONSTRUCTION REQUIREMENTS:**

**717.3.1 Mixing of Asphalt-Rubber:** The temperature of the asphalt-cement shall be between 375°F (191°C) and 425°F (218°C) 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 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 shall document that the proportions are accurate and that the rubber has been uniformly

incorporated into the mixture. Additionally, the Contractor 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 (177°C) and 400°F (204°C). Reaction time shall start after all of the material for the batch has been mixed and the minimum reaction temperature of 350°F (177°C) 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 shall provide a qualified person to perform the testing.

**717.3.2 Handling of Asphalt-Rubber:** Once the asphalt-rubber 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 shall be maintained between 325°F (163°C) and 400°F (204°C). However, in no case shall the asphalt-rubber be held for more than 10 hours at these temperatures. It shall be allowed to cool to a temperature of 250°F (121°C) 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, the Contractor 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 the asphalt cement.
- (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 52°F (11°C), and as needed to document other events which are significant to batch use and quality.

– End of Section –

**Section 610**

**610-13 COUPLINGS, JOINTS, GASKETS AND FLANGES**

(C) Bolts and Nuts

(1) For pipe 12 inches and smaller: Bolts and nuts for use in field connections or for connecting fittings shall be carbon steel equivalent to ASTM A307, Grade B, with zinc plating in accordance to ASTM B633 TY II, SC 2. Zinc plated bolts shall have class 2A threads and the nuts used with them shall have Class 2B threads. All bolt diameters shall normally be 1/8 inch smaller than the bolt hole diameter. High strength, heat treated cast iron tee-head bolts with hexagon nuts, all in accordance with the strength requirements of AWWA C-111, may be used in lieu of the zinc plated bolts and nuts for jointing mechanical joint cast iron or ductile iron pipe and fittings only.



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**CASE 11-04**

DATE: March 2, 2011

TO: MAG Specifications and Details Committee Members

FROM: Peter Kandaris, SRP Representative  
Outside of Right-of-Way Working Group

RE: **Rock Correction Procedure**

Purpose: MAG Detail 190, "Rock Correction Procedure for Maximum Density Determination," is not a construction detail, but a design guide for use by quality control technicians. The procedure does not belong in a construction specification. MAG 190 is referenced only in MAG Section 301 and can be replaced by the standard industry rock correction method, ASTM D4718.

Revisions: Replace reference to MAG Detail 190 in MAG Section 301 with ASTM D4718.

Delete MAG 190.

**SECTION 301****SUBGRADE PREPARATION****301.1 DESCRIPTION:**

This section shall govern the preparation of natural, or excavated areas prior to the placement of sub-base material, pavement, curbs and gutters, driveways, sidewalks or other structures. It shall include stripping and disposal of all unsuitable material including existing pavement and obstructions such as stumps, roots, rocks, etc., from the area to be paved.

**301.2 PREPARATION OF SUBGRADE:**

With the exception of areas where compacted fills have been constructed as specified in Section 211, in the areas where new construction is required, the moisture content shall be brought to that required for compaction by the addition of water, by the addition and blending of dry, suitable material or by the drying of existing material. The material shall then be compacted to the specified relative density. 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.

Subgrade preparation shall also include preparing the subgrade to the required line and grade for paved or unpaved shoulders, tapers, turnouts, and driveways, and at all other project locations where aggregate base and/or select material courses are used in accordance with the Project Plans.

**301.2.1** The Contractor may use removed existing asphalt concrete and other existing bituminous roadway surfacing materials originating on the project site, as embankment fill. All materials used shall be thoroughly crushed to sizes not exceeding four inches, or as approved by the Engineer. These asphalt/bituminous materials shall be placed not less than two feet below finished subgrade elevation.

Project earthwork quantities when included as separate contract pay items will include removed asphalt/bituminous material volumes, unless otherwise specified in the Special Provisions.

All unsuitable material and all excess material shall be disposed of in accordance with the requirements of Sections 205.2 and 205.6, respectively. When additional material is required for fill, it shall conform to Section 210.

**301.3 RELATIVE COMPACTION:**

The subgrade shall be scarified and loosened to a depth of 6 inches. Rock 6-inches or greater in size that becomes exposed due to scarification shall be removed from the scarified subgrade. When fill material is required, a layer of approximately 3 inches may be spread and compacted with the subgrade material to provide a better bond. The subgrade cut and fill areas shall be constructed to achieve a uniform soil structure having the following minimum compaction, measured as a percentage of maximum dry density when tested in accordance with AASHTO T-99, Method A, and T-191 or ASTM D-2922 and D-3017 with the percent of density adjusted in accordance with the rock correction procedures for maximum density determination, ~~Standard Detail 190~~ [ASTM D4718](#), to compensate for the rock content larger than that which will pass a No. 4 sieve. Unless otherwise noted in the project plans or project specifications, compaction shall be performed within 2 percentage points of the optimum moisture content.

(A) Below pavement, curb & gutter, attached sidewalk, roadway shoulders,

and other areas within right-of-way subject to vehicular traffic	95 percent
(B) Below detached sidewalk not subject to vehicular traffic	85 percent

**301.4 SUBGRADE TOLERANCES:**

Subgrade upon which pavement, sidewalk, curb and gutter, driveways, or other structures are to be directly placed shall not vary more than 1/4 inch from the specified grade and cross-section. Subgrade upon which sub-base or base material is to be placed shall not vary more than 3/4 inch from the specified grade and cross-section. Variations within the above specified tolerances shall be compensating so that the average grade and cross-section specified are met.

**301.5 GRADING OF AREAS NOT TO BE PAVED:**

Areas where grade only is called for on the plan shall be graded to meet the tolerances for the subgrade where subbase or base material is to be placed. The surface shall be constructed to a straight grade from the finished pavement elevations shown on the plans to the elevation of the existing ground at the extremities of the area to be graded.

**301.6 PROTECTION OF EXISTING FACILITIES:**

The Contractor shall exercise extreme caution to prevent debris from falling into manholes or other structures. In the event that debris should fall into a structure it shall immediately be removed.

**301.7 MEASUREMENT:**

Measurement for Subgrade Preparation will be by the square yard. The area to be measured will be the total accepted area of new asphalt or Portland cement pavement, including paved shoulders, tapers, and turnouts, and unpaved roadway shoulders. Measurement will also include driveways that are paved or are surfaced with aggregate base or select materials. The area under concrete curb and gutter, sidewalk, concrete driveway entrances, and concrete alley entrances will not be included in this pay item.

Project earthwork quantities for Roadway Excavation, Borrow Excavation, and Fill Construction shall not be separately measured when they are not listed as separate line items on the fee proposal form. In such case, unless otherwise specified, payment for said earthwork items shall be included in the unit price for Subgrade Preparation.

**301.8 PAYMENT:**

Payment for Subgrade Preparation will be made only when it is performed for street or roadway paving projects.

Payment shall be compensation in full for stripping, scarifying, grading, excavating, hauling, filling, compacting, and disposing of excess or unsuitable materials, together with all costs incidental thereto.



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**CASE 11-05**

DATE: March 2, 2011

TO: MAG Specifications and Details Committee Members

FROM: Peter Kandaris, SRP Representative  
Outside of Right-of-Way Working Group

RE: **Water Requirements**

Purpose: MAG Section 225, "Watering," provides no technical guidance for the performance of work and is general in scope. The section should be placed in Part 100, General Conditions.

Revisions: Move all of MAG 225 to MAG Section 104.1.3.

Re-number MAG 104 as needed.

Delete MAG 225.

**SECTION 104**

**SCOPE OF WORK**

**104.1 WORK TO BE DONE:**

**104.1.1 General:** The Contractor shall perform all work as may be necessary to complete the contract in a satisfactory and acceptable manner in full compliance with the plans, specifications and terms of the contract.

In the event a conflict exists between Contract Documents the order of precedence listed in descending order shall be as follows:

- Change Orders
- Addenda
- Special Provisions
- Project Plans
- Contracting Agency's supplements to the MAG Uniform Standard Specifications and Details
- MAG Uniform Standard Specifications
- MAG Standard Details

Unless otherwise specified in the special provisions, The Contractor shall furnish all labor, materials, equipment, transportation, utilities, services and facilities required to perform all work for the construction of the project within the time specified. All existing concrete or bituminous surfaced sidewalks, driveways and alleys which were disturbed by the Contractor at the direction of the Engineer, shall be replaced. Private concrete or bituminous surfaced sidewalks and driveways, which were disturbed by the new improvements must be replaced. The slope of the replaced sidewalk or driveway must comply with the agency's minimum standards. If the standard cannot be constructed within the disturbed area, the Contractor shall remove and replace to a distance required to obtain the slope. Payment for such work will be made under the respective pay items provided for in the contract, or by agreed prices in advance, if no pay items are provided for in the contract.

**104.1.2 Maintenance of Traffic:** The Contractor's operations shall be in accordance with the traffic manual and/or policies of the appropriate public agency having jurisdiction over the project and Section 401. These operations shall cause no unnecessary inconvenience to the public and public access rights shall be considered at all times. Unless otherwise authorized in the specifications or on a temporary basis by the Engineer, traffic shall be permitted to pass through the work area. The Contractor shall coordinate with the various agencies both commercial and public, involved in the collection and removal of trash and garbage, so that adequate services are maintained.

Safe and adequate pedestrian and vehicular access shall be provided and maintained to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, motel, hospitals, fire stations, police stations, and establishments of a similar nature. Access to residential properties shall be in accordance with Section 107.

Grading operations, roadway excavation and fill construction shall be conducted and maintained in such a manner as to provide a reasonably satisfactory and safe surface for vehicular and pedestrian traffic. When rough grading is completed, the roadbed shall be brought to and maintained in a reasonably smooth condition, satisfactory and safe for vehicular traffic at the posted speed limit. Pedestrian walkways shall be provided and maintained in a like manner. The Contractor shall accomplish any additional grading

operations and/or repairs, including barricade replacement or repairs during working and nonworking periods which, in the opinion of the Engineer, are required.

In the event of abnormal weather conditions, such as windstorms, rainstorms, etc., the Contractor shall immediately inspect his work area and take all necessary actions to insure that public access and safety are maintained.

The Contractor shall provide the Engineer with the emergency address of his representatives as required by Section 105.

**104.1.3 Water Supply:**

Water shall consist of providing a water supply sufficient for the needs of the project and the hauling and applying of all water required.

The Contractor shall make arrangements for and provide all necessary water for his construction operation and domestic use at his own expense.

If the Contractor purchases water from a water utility at a fire hydrant on or near the project, all arrangements shall be made by him at his own expense and payment made direct to the water utility as agreed upon.

The Contractor shall use only those hydrants designated by the water utility in charge of water distribution and in strict accordance with its requirements for hydrant use.

The Contractor shall furnish all connections, wrenches, valves and small tools that may be necessary to meet the requirements of the water utility pertaining to hydrant use.

The tank truck and/or trailer shall meet all safety and licensing regulations and the water shall be applied by sprinkling with tank trucks equipped with spray bars and suitable apparatus.

No measurement will be made of water, unless otherwise provided for in the special provisions or proposal.

The cost of watering will be included in the price bid for the construction operation to which such watering is incidental or appurtenant, unless otherwise provided for in the special provisions or proposal.

**104.1.3-4 Cleanup and Dust Control:** Throughout all phases of construction, including suspension of work, and until final acceptance of the project, the Contractor shall keep the work area clean and free from rubbish, excess materials and debris generated by Construction Activities.

At disposal sites and storage sites, other than agency landfills, the Contractor shall be responsible for all required dust control measures. This includes temporary yard or staging areas.

The Contractor shall take whatever steps, procedures or means required to prevent any dust nuisance due to his construction operations. The dust control measures shall be maintained at all times to the satisfaction of the Engineer and in accordance with the requirements of the Maricopa County Bureau of Air Pollution Control Rules and Regulations.

Failure of the Contractor to comply with the Engineer's cleanup orders may result in an order to suspend work until the condition is corrected. No additional compensation or time will be allowed as a result of

such suspension and the Engineer has the authority to take such other measures as may be necessary to remedy the situation. Subsection 104.2.5 applies.

**104.1.45** Final Cleaning Up: Before final acceptance, all private or public property and grounds occupied by the Contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures and equipment, and all parts of the work area shall be left in an acceptable condition.

#### **104.2 ALTERATION OF WORK:**

**\*104.2.1 By the Contracting Agency:** The Contracting Agency reserves the right to make, at anytime during the progress of the work, such alterations in the details of construction and such increases or decreases in quantities as may be found necessary or desirable. Such alterations and changes shall not invalidate the contract nor release the surety and the Contractor agrees to perform the work as altered, the same as if it had been a part of the original contract. The Engineer will issue Change Orders to cover unforeseen circumstances which make it impossible to carry out the work in accordance with the original contract plans and specifications.

If the alterations or changes made by the Contracting Agency increases or decreases the total cost of the contract or the total cost of any major item by more than 20 percent, either party may request an adjustment in payment in accordance with Section 109.

#### **104.2.2 Due to Physical Conditions:**

\*(A) Should the Contractor encounter or discover during the process of the work, subsurface or latent physical conditions at the site differing materially from those indicated in the contract, or unknown physical conditions at the site of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract, the Engineer shall be promptly notified in writing of such conditions before they are disturbed. The Engineer will thereupon promptly investigate the conditions and, if he finds they do so materially differ and cause an increase or decrease in the cost of or the time required for performance of the contract, an equitable adjustment will be made and the contract modified in writing accordingly.

\*(B) If at the time of opening up any portion of the work, material from which the subgrade, backfill or bedding is to be constructed contains an excess of moisture so that the required compaction cannot be obtained without additional manipulation, the Engineer will determine the cause of such condition. If the cause of such condition is determined to have been unforeseeable and beyond the control of and without fault or negligence of the Contractor, the Engineer will determine whether the material shall be aerated or removed and replaced. Such work shall be done as directed and will be paid for as provided in Section 109.

\*(C) Failure to notify the Engineer of the conditions described in A and B above prior to doing any work may be just cause to reject any claims for additional monies and/or time. \*(D) Material in ditches and ditch banks that contains moisture in an amount considered excessive by the Engineer shall be removed and shall be aerated to the extent required by the Engineer before compaction is effected. No measurement or direct payment for the removal and aeration of such material will be made.

\*(E) After any portion of the work has been opened up, saturation of material caused by irrigation water, storm drainage, weather or such similar causes will be considered as within the responsibility of the Contractor.

**\*104.2.3 Due to Extra Work:** The Contractor shall perform unforeseen work, for which there is no unit bid price in the proposal, whenever it is deemed necessary or desirable by the Engineer in order to fully complete the work as contemplated. Such work shall be governed by all applicable provisions of the contract documents and payment will be made in accordance with the provisions set forth in Section 109.

Should the Contractor claim that any instructions received involve extra work under the contract, he shall give the Engineer written notice within two work days after receipt of such instructions, and in any event before proceeding to execute the work, except in emergencies endangering life or property. No claim shall be valid unless written notice is given.

If this extra work is performed by others, the Contractor agrees to cooperate fully with the other source accomplishing this work and agrees that this action shall not invalidate the Contract or release the surety.

**104.2.4 At the Contractor's Request:** Changes in the plans or specifications, which do not materially affect and are not detrimental to the work or to the interests of the Contracting Agency, may be granted to facilitate the work. Requests shall be in writing and submitted to the Engineer for approval. These changes, if approved and when resulting in a saving to the Contractor, will be made at an equitable reduction in cost or in no case at any additional cost to the Contracting Agency.

**104.2.5 Due to the Failure of the Contractor to Properly Maintain the Project:**

(A) If the Contractor fails to provide adequate Maintenance of Traffic or Cleanup and Dust Control or to correct deficiencies resulting from abnormal weather conditions, the Engineer has the authority to suspend the work wholly or in part until this condition has been corrected.

(B) If the Contractor fails to comply with the Engineer's written order to provide adequate maintenance of traffic, cleanup, dust control, or to correct deficiencies resulting from abnormal weather conditions, the Engineer has the authority to have this work accomplished by other sources.

(C) The Contractor agrees to cooperate fully with the other source accomplishing this work and agrees that this action shall not invalidate the Contract or release the surety.

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\*Not applicable to Improvement District Projects.



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(602) 236-5900

DATE: February 2, 2011  
TO: MAG Specifications and Details Committee Members  
FROM: Peter Kandarlis, SRP Representative  
RE: **Modified CLSM (MAG 728) Backfill Using Fly Ash**

SRP recently tested and placed modified ½-sack cement Controlled Low Strength Material (CLSM) slurry backfill in municipal right-of-way to improve thermal resistivity properties while retaining excavation and strength characteristics. Summary test results are attached.

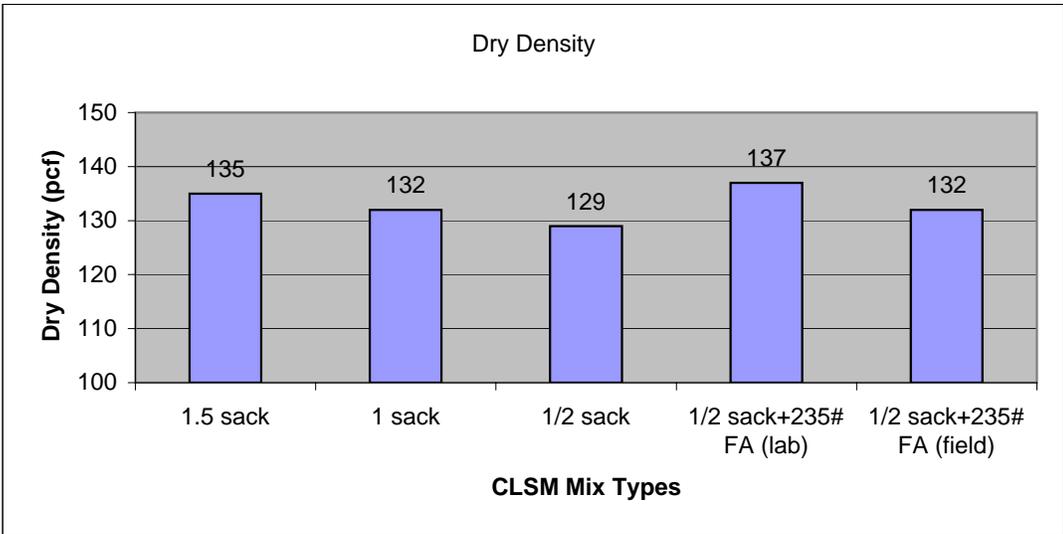
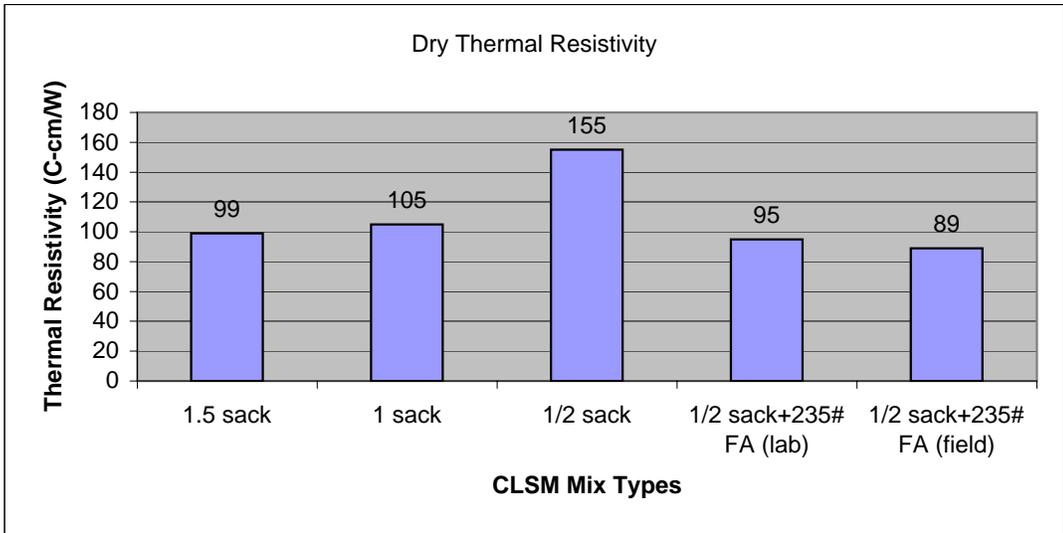
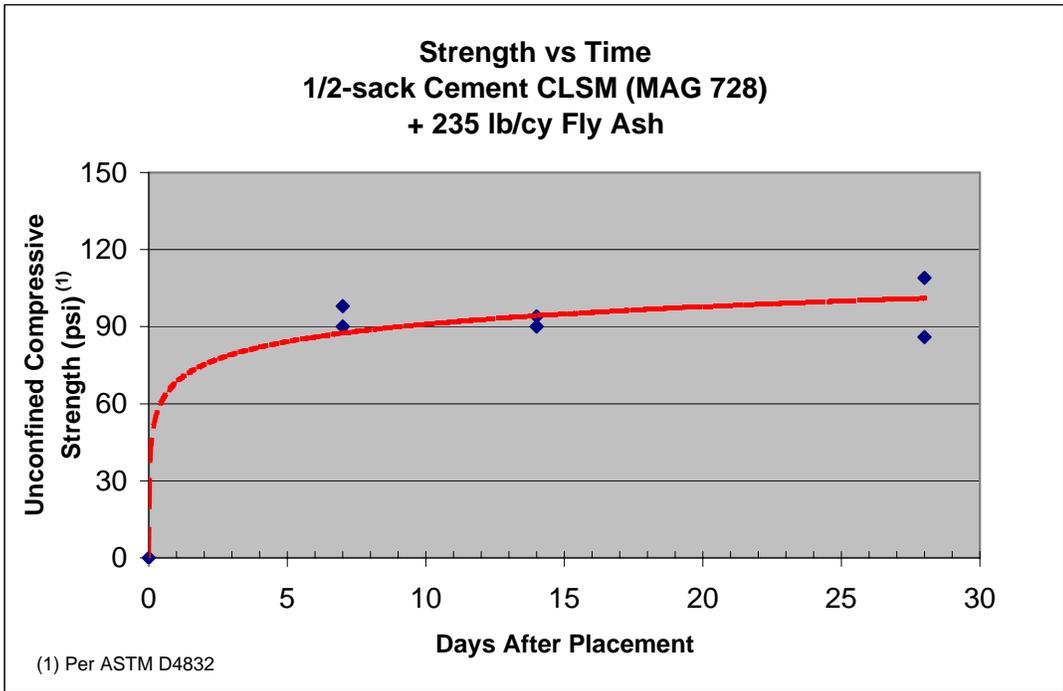
The project was performed at the intersection of Greenfield and Pecos Roads in Gilbert where numerous Town of Gilbert and City of Mesa underground utilities were in place, with more planned in the future. The new underground 69kV transmission line duct bank needed to be 15.5 to 17.0 feet below grade to clear existing facilities in Greenfield Road, thus requiring thermal backfill to the ground surface. Placement of standard thermal backfill would have created a low-strength cementitious wall (minimum 500 psi unconfined compressive strength) across the underground profile. Municipalities required the customer requesting the underground work encase all existing and future utilities in carrier pipes at least 10 feet beyond the backfill boundaries if the standard thermal backfill was to be used.

SRP, working with Geotherm, Inc. of Dublin, California, and Rock Solid's Chandler plant, developed modified ½-sack cement CLSM meeting the requirements of the newly adopted MAG Section 728 revisions. The mix included 235 pounds per cubic yard fly ash. Cement content was increased slightly, from 47 to 50 pounds per cubic yard and coarse aggregate was increased from the standard range of 45%- 50% to 55%. Water was reduced to 32 gallons per cubic yard producing a slump ranging from 6" to 9". A 5 cubic yard production run was performed by Rock Solid and tests from that run showed 28-day unconfined compressive strengths ranging from 86 to 109 psi, well below the generally accepted value of 150 psi for excavatable materials and comparable to the standard ½-sack cement mix. The thermal resistance improved by over 50%.

A future City of Mesa utility is to be installed in Pecos Road later this year that will require excavation of the backfill. SRP will monitor and record excavation information from that project and provide the committee a report upon completion.

A handwritten signature in black ink, appearing to read 'Peter Kandarlis', with a stylized flourish at the end.

Peter Kandarlis, SRP  
Senior Principal Geotechnical Engineer



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February 2011

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February, 2011

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February, 2011

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