901 MOBILIZATION

Mobilization is a contract item established to compensate the contractor for move-in costs and certain other startup costs incurred as the project work begins. The item is set up so that partial payments are made as the work progresses.

There are four milestones that trigger mobilization partial payments:

1. The preconstruction conference/partnering workshop.
2. The point when there is a significant amount of equipment on the project site.
3. When 5% of the contract is completed excluding stored material payments.
4. When 10% of the contract is completed excluding stored material payments.

There are caps in the Specifications for how much the mobilization bid amount can be. If the contract is $5,000,000 or less the contractor can put up to 12% of the contract value and if the project is more than $5,000,000 it is 10%. If the contractor exceeds these caps the excess mobilization will be paid upon completion of the project.

Typical payments are broken into 25% increments of the total lump sum for most projects but there are projects that may have the 3% or 2.5% rule outlined in Table 901-1.

The first milestone is not reached until the preconstruction conference has been held and all the documentation required by Subsection 108.03 has been submitted complete enough for review. The table in Subsection 108.03 of this manual lists all the submittals required at the preconstruction conference, including those specifically required by 108.03. The Special Provisions may have additional submittal requirements under 108.03. A satisfactory submittal should be one that can be reviewed by the Department without being sent back to the contractor for incompleteness. For example, a generic safety plan that doesn't address some of the specific project safety hazards would be unsatisfactory and could be used as a basis for withholding the first mobilization partial payment.

The Department considers the preconstruction submittal documents part of the contractor's preparatory work paid for under mobilization. Thus, to get paid for mobilization, complete documents need to be submitted.

The second milestone occurs when a significant amount of equipment has been mobilized to the project site. What constitutes significant is left up to the interpretation of the Resident Engineer. However, to be consistent statewide the Resident Engineer should take into consideration the size of the project and how much equipment will be needed initially to complete the first 5 percent of the contract work. Setting up a trailer, installing fences and signs for the contractor's yard does not qualify for this mobilization milestone. Nor does parking a single piece of equipment, like a frontend loader, to be used much later in the project qualify.

The third milestone is reached when 5 percent of the project work has been completed in terms of dollars paid to the contractor. The 5 percent includes the two previous mobilization partial payments.

There is some confusion as to when the 5 percent should be paid, in the month that it is reached or in the following month. The 5 percent milestone is triggered when the work is completed in the field, not when the field office prepares the monthly estimate. The milestone can be reached at any time during the month and is not necessarily the end of the month. For example, if 10,000 cubic yards is needed to trigger the 5 percent mobilization payment, and this point is reached halfway through a given month, then the 5 percent mobilization would be paid on the estimate prepared at the end of that month (the next estimate after the 5 percent is reached). The "next estimate" provision was placed in the Standard Specifications to prevent the contractor from requesting a supplemental estimate (see Subsection 109.06 of this manual) every time a mobilization milestone was reached

The same reasoning applies to the fourth and final mobilization partial payment, when 10 percent of the work is complete.

Although not explicitly stated in the Standard Specifications, the mobilization milestones must be paid in order: the second payment cannot be made before the first. The numbering of the milestones implies an order that should be followed. A contractor that has submitted incomplete documents required by Subsection 108.03 cannot receive the first or any subsequent mobilization partial payments until complete documents are submitted.

The mobilization pay item should not change due to changes in other work items or due to altered quantities.

902 CHAIN LINK FENCE

Fencing with secured access gates should be installed on a project as soon as possible. Although fences may restrict the contractor's access to parts of the site, they do protect the public from the safety hazards associated with highway construction, refer to Subsection 107.08. Permanent fencing is preferred over temporary fencing because permanent fencing is usually more secure.

Fence lines are to be staked so that the fence posts are 6 inches from the right-of-way line, unless otherwise specified on the plans.

When building a new fence requires removal of an existing fence or erection of temporary fences, the inspector and the contractor are to work with the property owner to accomplish the changes with the least disruption and inconvenience.

902-2 Materials

Two materials options are permitted for fence material: zinc-coated, galvanized, or aluminum coated steel; however, only one kind of material will be allowed on each project. This material requirement is due to the corrosive reaction caused by interaction of dissimilar metals.

Zinc-coated metals have a dull-to-very dull (almost greenish gold) appearance when the zinc coating has the proper thickness. A shiny surface is a good indicator that the coating may be too thin. If this is the case, the inspector should take a sample before the material is installed and have the sample sent to the Structural Material Testing Section of the Materials Group for a coating thickness check. Additional sampling methods are to be carried out per Arizona Test Method ARIZ109.

902-3 Construction Requirements

When a chain link fence is installed over irregular ground, it may be necessary to do a considerable amount of grading along the fence line to obtain the uniform, bottom-of-fence line clearance specified in the standard drawings.

Rock or hard ground makes installation of fence posts difficult, hindering either the post driving or hole excavation. It may be necessary to increase inspection to assure that posts are anchored to the proper depth and diameter.

When Class B or utility concrete is used to anchor fence posts, the contractor will have to wait several days before stretching the fence fabric. The concrete needs to develop adequate strength and stiffness to resist the bending forces developed in the posts when the fence fabric is stretched and tensioned. If the contractor is in a hurry and with the approval of the Resident Engineer, Class S concrete with high early strength cement can be used which may allow fabric stretching and tensioning the day following fence post installation.

Guidelines For Inspecting Chain Link Fence:

- Do the materials conform to the plans and specifications, (refer to Standard Drawings C-12.20 1 through 3), and are the materials certifications available for those items requiring them?
- Are the pole foundations free of debris and the correct diameter and depth as specified on the plans?
- For pole foundations, is the approved type of concrete being used?
- Are the fence posts the correct type, e.g. wall thickness, diameter and length as specified on the plans?
- Are the posts spaced at 10 feet or less intervals?
- Have intermediate posts assemblies been installed for continuous fencing distances greater than 500 feet?
- Have gate post assemblies been placed at the prescribed locations shown on the project plans?
- Has the concrete used in foundations cured at least 72 hours before the fabric is stretched? Unless high-early strength concrete was used, then allow for a 24 hour minimum cure time.
- Is the wire fabric of proper height and gauge as specified on the plans? (Type 1 and Type 2)

- If the fence height is under 60 inches, the fabric should have the knuckled selvage ends at the top along with twisted and barbed selvage ends installed at the bottom, unless otherwise specified on the plans.
- If the fencing height is 60 inches or greater, the fabric should have twisted and barbed selvage ends at the top and the bottom.
- Are the truss rods and truss tighteners of the proper diameter and thickness as specified on the plans?
- Are the stretcher bars and stretcher bar bands of the proper diameter and thickness as specified on the plans?
- Are the fence post wire ties of proper gauge as specified on the plans?
- Are the strain wire, hog rings of proper gauge as specified on the plans?
- Are the strain wires of proper gauge as specified on the plans?
- Is the strain wire and bottom of the mesh fabric at the correct height above the finished grade? Remember to include additional height for unplaced decomposed granite.
- Does the fence line follow the contour of the finished grade?
- Has the chain link fabric been installed on the correct side of the posts? (Away from mainline traffic)
- Has the fabric been stretched taut (without deforming) and securely fastened to the posts as well as the top and bottom strain wires at the specified design intervals?
- Are all nuts and bolts facing the correct direction (toward mainline traffic) and tightened to the designed specifications?

Fence materials that are thicker or have thicker coatings than required are usually acceptable to the Department. Unless there is an appearance problem with the fence, the Resident Engineer can approve the thicker materials by a no-cost minor alteration.

903 WIRE FENCE

Before fence construction starts on a project, the inspector and Resident Engineer should study the plans diligently. Special attention should be given to right-of-way lines, access control lines, location of gates, cattle guards, flood gates, and angle points in order that the contractor may be given complete, accurate information necessary to begin fence construction without delay or interruption. The inspector should know what type of fencing materials and hardware are specified. For example, is barbed wire or barbless wire specified? If game fencing is specified, is the bottom wire barbless? Are any special details required for environmental mitigation?

When constructing or reconstructing fencing, the contractor shall be held strictly responsible for any and all damage to private property during or as a result of their operations. This includes losses and accidents caused by such things as loose livestock.

903-2 Materials

The inspector must be sure that all fence materials have been certified, tested, and approved. Project samples must be taken as outlined in the Materials Testing Manual as soon as materials are delivered to the project.

903-3 Construction Requirements

Close inspection during construction is necessary to see that posts are driven to the proper depth and spacing shown in the Standard Drawings. This is especially important where post driving is difficult. After all required line, intermediate, and corner posts assemblies have been placed, the wire should be stretched taut and securely fastened to each post. Post concrete should cure 72 hours minimum before any fence wire is stretched and tied. After the required strands of wire have been properly placed, the guy wires, sag weights, and other details should be completed as required.

Avoid construction of fencing in washes or along bank edges where erosion may destroy the usefulness of the fence. Wing fences at box culverts need not be an extension of the wing line. The alignment of the wing fence can be adjusted away from the channel to keep as much of the fence as possible out of the drainage area. These adjustments will often result in the need to increase the length of the flood gates. Probably the most important consideration is that the gate/end post assemblies are located well away from areas subject to erosion.

The installation of the gates, hinges, and latches should allow them to operate freely. They should open to the full opening size in the direction indicated. The upper post hanger of Type I line fence gates shall be installed so that the gate cannot be lifted and removed.

Carefully check horizontal and vertical angle points to determine whether corner posts or diagonal tension wires are needed.

The clearance between the bottom wire and the ground must be checked since extra posts, sag weights, or special treatment may be needed.

Sag weights shall be prefabricated 100 pound concrete blocks. This is sometimes necessary to prevent line posts from being pulled out of the ground upon tensioning of the barbed wire or woven wire fabric.

It should be noted that flood gates are to be constructed to the same requirements specified for barbed wire construction, except that the concrete sag weights shall weigh 35 pounds.

Unusual ground conditions should be looked at to determine whether a modification of the standard fence treatment is called for, or if perhaps some fence can be eliminated.

Inspection Guidelines For Wire Fence And Gates:

1. Do the following materials conform to the plans and specifications, and are material certifications available for those items requiring them: (Reference Section 902 of this manual under Materials and Installation Guidelines)

    - Barbed/woven wire zinc or aluminum coated and of the same type for the entire project
    - Gates, along with gate hardware?
    - Posts; intermediate and all post assemblies?
    - Fasteners, latches, hinges/hangers, and any additional hardware?

2. Have adequate measures been taken to protect livestock while building or rebuilding fencing?

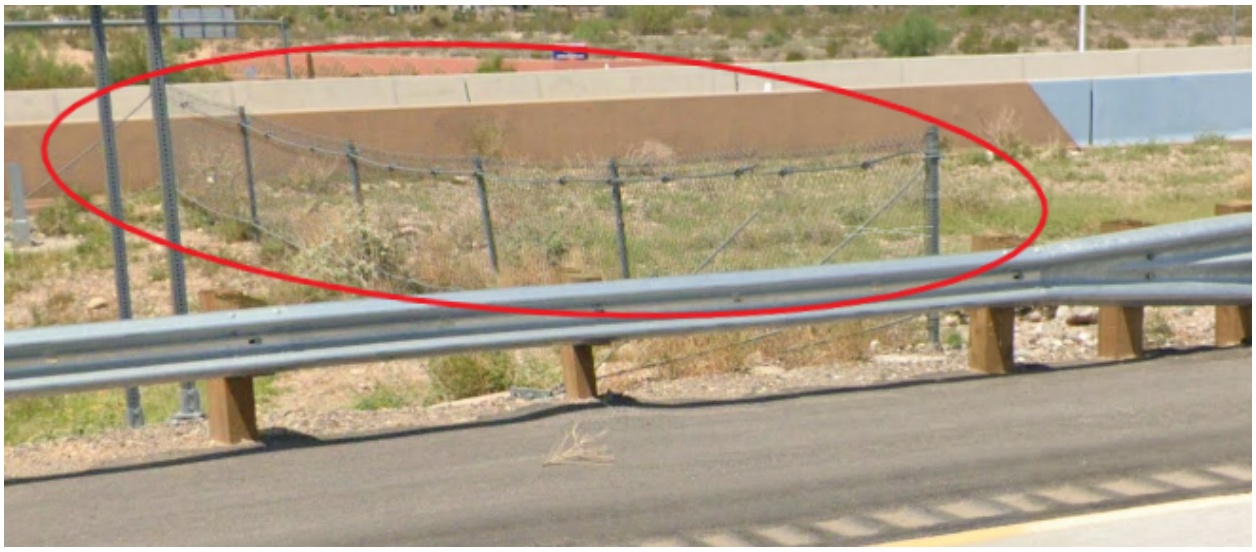
3. Has the fence line been cleared or graded in accordance with the project plans and specifications?

4. For installation procedures reference Project Drawings, Standard Drawings C-12.10 Sheets 1 - 5 and the manufacturers recommended installation procedures.

    - Are posts of the proper length and have they been driven/set to the proper depth, are posts spaced correctly, are the posts plumb, and does the fence have the correct alignment with the ROW?
    - Has the wire been stretched taut; not over stretched or sagging, and fastened to each post? Was the wire stretched on the outside of posts around curved areas? Is there only one wire splice per panel?
    - Is the vertical spacing between wire strands correct and have stays been installed at the desired intervals?
    - For Type I gates, is the upper post hanger installed so the gate cannot be removed?
    - Is the concrete (bag mix) used for footings and foundations on the APL or has it been approved?
    - Is the concrete being mixed properly, Per ADOT and manufacturer recommendations.
    - Have the Intermediate post assemblies and corner posts assemblies been installed at all required locations?
    - Has fencing been properly tied into the structures?
    - For low lying watershed areas such as washes or creeks, have the posts been installed and if applicable weighted to plan specifications?

904 CHAIN LINK CABLE BARRIER

Chain-link cable barrier is a safety device, typically installed in the roadway median in between bridge abutments.



904-3 Construction Requirements

It should be noted that the concrete anchor blocks must be flush with the ground so that they do not catch on a vehicle passing over them. At the same time, they must be well-drained so that water doesn't collect where it can corrode the hardware or soften the ground around the block.

The distance from the barrier to the top of the slope must be as specified on the plans. If the distance is too short, the barrier will not stop a vehicle before it drops off the slope.

All the fittings must be accurately placed and torqued as specified.

As with all safety devices, it is legally imperative that the barriers are built strictly according to the plans.

905 GUARDRAIL

The Project Plans will specify the locations, type, and quantity of guardrail to be installed, removed or reconstructed. Installation will be in accordance with the appropriate standard drawings and special details and manufacturer's approved drawings. Installation of guardrail has evolved into a relatively complex procedure. The standards and manufacturer's drawings for guardrail are being constantly updated to improve the design and facilitate maintenance. It is imperative that construction personnel are aware of the latest guardrail standards and manufacturer's drawings. In order to assure installation in accordance with the correct drawings, the pre-activity meetings are required. This is discussed in more detail at the end of this section. Occasionally, a supplemental agreement to address revisions to the system after the contract has been awarded may be necessary. This can be conveyed to the contractor at the pre-activity meeting.

When the contractor is given the option of selecting an end treatment, the type of device to be used should be submitted at the pre-activity meeting. If this is not possible, the type must be submitted before the contractor orders delivery of guardrail materials to the site. This will provide the lead time necessary for the Resident Engineer to determine the final location for end treatments, which in turn affects the length of need, the total guardrail length and the quantity of material ordered. In the event of major changes in guardrail locations, the roadway designer should be consulted for placement criteria and standards.

Proprietary items, such as guardrail end treatments, change as design modifications are introduced. The supplier of a proprietary item is required to submit the changes to the ADOT New Product Committee. Changes which are approved are on file with the Standards Engineer in the Roadway Design Section. Installation guidelines shall also be furnished with the units so that the contractor and inspectors can confirm that the installed end treatment meets the NCHRP 350 and manufacturer's requirements.

When staking post locations be sure to locate all drainage structures so that where possible the post location can be adjusted to eliminate any conflicts or the need for an anchoring device. Guardrail layout staking generally consists of marks on the pavement to locate the longitudinal position of the post together with the offset distance to the post. The offsets at flared end sections can be obtained from the Plans Detail Layout Sheets. Stakes or markings for guardrail control are generally adequate if set at 50-foot intervals for tangent sections and 25-foot intervals on curves.

Wood posts are to be inspected in accordance with section 1012 of the ADOT Standard Specifications before they are placed in pre-punched, or pre-drilled holes and driven the final 10-inches to grade. Steel guardrail posts may be driven full depth, or placed in manually or mechanically dug holes and driven the final 10-inches to grade. When posts are placed in manually or mechanically dug holes, the space around posts must be backfilled with moist soils placed in compacted lifts as approved by the RE. Excessive driving effort, in some cases will cause damage to the post and which may be cause for rejection of the post. When posts are set in position, each post must be plumb, true to alignment and grade, and surrounded by well compacted ground. In paved areas, the displaced material from post driving will often cause the pavement to bulge upward or crack an adjacent curb. If either of these occurs, the contractor is required to use other methods that will not damage existing pavements or structures and to repair any damage that has been caused by post installation.

On occasion the contractor may encounter rock that prevents the driving of posts to the full depth for W-beam guardrail. Requests for changes should be submitted to the RE through the project RFI process. Approval for any changes to end treatments must be obtained from the manufacturer.

When posts are set in concrete at the top of the concrete leave-out, material (normally 1-sack grout) adjacent to the posts should be finished in accordance with the plans or manufacturer's drawings. For asphalt pavement the space around the posts is backfilled with moist soils, compacted in lifts and topped with 3" of compacted bituminous material to match roadway cross slope.

Blocks are to be toe-nailed to the post with two galvanized sixteen-penny nails. The tops of the post and block are designed to be flush; a maximum of 1/2-inch difference in the elevation of the top of the post and block is permitted.

The rail should be inspected for any damage that may have occurred to the rail itself or to the galvanizing due to rough handling. A Certificate of Compliance is required for all rail and should be furnished before construction starts. All guardrail fasteners also require a Certificate of Compliance and one sample of each item.

Rail elements should be assembled to present a smooth, continuous appearance with the top of the rail being in near perfect alignment horizontally and vertically with the roadway. There should be no noticeable sags or humps. Rail laps must be oriented in the direction of traffic to the closest lane.

The reflector tabs for guardrail are thin and pliable, so they can be bent over the head of the bolt. The tabs are bent to keep them from falling off when the bolt loosens due to the drying and shrinking of the posts and blocks. The reflective material is high intensity reflective type sheeting. See the Standard Specifications for post spacing and color requirements.

Projects with an average elevation over 4000 feet require flexible markers in addition to reflector tabs. Sheet 2 of the plans should show average project elevation. See section 905 of the ADOT Standard Specifications for height, attachment hardware, post spacing, and color requirements.

The end treatments (a.k.a. terminals) for guardrail are numerous and each has specific construction requirements. Therefore it is important that construction personnel carefully review and adhere to all the construction details in the Project Plans, Standard Drawings, Standard Specifications, Special Provisions, Manufacturer's Drawings and, Manufacturer's Installation Manual associated with end treatments. Delineation of guardrail posts must be done in accordance with Table 905-1 of the Special Provisions. See the Special Provisions and Standard Specifications for post locations and type of barrier marker required.

When existing guardrail elements are to be reused, it is important to permanently mark any damaged or otherwise unsuitable elements before construction begins. This can be accomplished with the use of a high visibility marker paint; to prevent the deficient material from being incorporated into the final product. Reconstruction of guardrail shall meet the same requirements as construction of new guardrail. Existing guardrail designated on the Project Plans to be reconstructed should be carefully removed from the old location, and reused materials should be inspected with care. Sharp kinks or enlarged bolt holes are reasons for the rejection of rail elements. Posts that are severely cracked, rotted or splintered are to be rejected, see requirements of Task Force 13, Guide to Standardized Roadside Hardware. The Special Provisions or the plans may require all reconstructed posts to be replaced with new posts, if the Resident Engineer requested it during the project planning, or design phases.

It should be noted that the Standard Specifications prohibit the use of a cutting torch for the making of new bolt holes. Heating guardrail weakens the metal around the bolt hole so that the bolt head may pull out under the force of impact. The only acceptable methods of making bolt holes in the field are drilling or punching; if a punching method is used, the inspector should ensure that the process is not deforming the rail section in any way.

Prior to acceptance, each section of guardrail should be inspected utilizing the appropriate quantified checklist for the specific type of guardrail installed.

Inspection Guidelines For Guardrail:

- Schedule the pre-activity meeting sufficiently in advance of ordering the materials to resolve all issues; a minimum of 20 days in advance is recommended. Attendees should include the superintendent, the subcontractor(s), the foreman installing the devices, the RE, the Project Supervisor and any inspectors who will be working on the installations.
- A suggested agenda for the pre-activity meeting for Roadside Safety Devices is shown in Exhibit 905-1. The RE should assign discussion roles and times.

- It is understood the contractor will bring the manufacturer's installation requirements to the meeting, including the manufacturer's drawings approved by ADOT. When a newer end treatment system has been approved the RE should encourage the contractor to install the current approved system. ADOT personnel will bring the current Quantlists.
- The most recent manufacturer's approved drawings can be found on the Roadway Design web page.
- Current versions of ADOT Inspection Quantlists for Guardrail End Sections can be accessed using the Construction software application. Additional Quantlist access instructions may be found in Subsection 105.12 of this manual.

ROADSIDE SAFETY DEVICES

PRE-ACTIVITY MEETING AGENDA

1. **Introduction of participants**
2. **Review Special Provisions**
3. **Discuss Barrier Summary Sheets; Roadway Engineering Memorandum, dated 6-27-2002**
4. **Review Plans Layout Sheet:**
    - Dimensions of widening
    - Foreslope rate
    - Borrow source; if needed
    - Bituminous material; source and type
5. **Discuss schedule and sequencing:**
    - Blue staking
    - Surveying layout
    - Borrow for pad construction
    - Potential drainage conflicts, e.g. created by widening
    - Units to be installed before or after paving
    - Compaction around posts
    - Removal of existing rail and unit completion in same day
    - Traffic control
6. **Review traffic standards and specifications for delineation**
7. **Review manufacturer's approved drawings & other standards**
8. **Review the manufacturer's installation requirements, e.g. manuals and instructions**
9. **Review the ADOT checklists**
10. **Discuss governing order of requirements, authority and escalation practices**

Exhibit 905-1 Suggested Pre-activity Agenda for Roadside Safety Devices

906 CATTLE GUARDS

The Project Plans will specify the location and type of cattle guards to be constructed. Each cattle guard must be constructed in conformance with the appropriate Standard Drawings or any special details included in the plans. The item itself consists of furnishing all materials and constructing new cattle guards or reconstructing existing cattle guards as noted on the plans.

Completed cattle guards must be well-drained to prevent ponding of water in the structure. Cattle guards should be carefully constructed to the specified grade and cross slope, with special care being taken to achieve a bump free, smooth riding installation. Errors in the elevation of the cattle guard or the approach grade that cause a bump for traffic must be corrected.

Inspection Guidelines For Cattle Guards:

- Do the materials conform to the plans and specifications (Refer to Standard Drawings C-11.10 (1 through 4), and C-11-20.
- Are all steel parts primed in accordance with Section 1002?
- Are all materials certifications available for those items requiring them?
- If the unit is precast, is the roadway longitudinal grade no greater than 6 percent and does the Certificate of Compliance match the unit and is the unit identified as an ADOT cattle guard?
- Has the exposed ground surface been adequately prepared and compacted to receive a precast unit?
- Does the rebar conform to Sections 1003 and 1004?
- Does the grade and cross slope conform to the surface of the finished pavement and is the unit at the correct elevation as shown on the plans?
- Is the approved type of concrete being used per Section 1006?
- Prior to pouring concrete, is the excavation free of debris and the correct dimension and depth as specified on the plans?
- Has the concrete been finished and cured in accordance with the specifications?
- Does the backfill material conform to Section 203-5 and has the backfill material been compacted to at least 95% of maximum density?
- No rocking is observed between the grille unit tread assembly and the steel angle bearing surfaces and no gap greater than 1/32 inch exists between any pair of bearing surfaces, when a unit or assembly is not under load, spiked, welded or otherwise held in place.
- Have all nuts and bolts securing the grille unit been installed, torqued or tightened to the designed specifications?

907 DAMPPROOFING AND WATERPROOFING CONCRETE SURFACES

There is a tendency to be careless with dampproofing and waterproofing because the surfaces will be buried and it is assumed that appearance is not important. Appearance is important because creases, spotty sealant coverage, loose ends, uneven appearance and other visual blemishes may indicate defects and potentially reduce the service life of the water proofing material thereby no longer protecting the structure from moisture.

Among the most important things to watch for are a dry surface before treatment and a smooth coverage of the waterproofing coating. A dry surface, besides increasing the adhesion of the product, reduces the possibility of vapor buildup under the coating which can cause a rupture and compromise the water seal. Surface depressions and high spots in the waterproofing are to be avoided because they create weak areas that can be easily broken during backfilling or settlement. If the surface being treated becomes wet from rain or for any other reason, it must be dried completely before allowing the work to proceed. The contractor must strictly adhere to manufacturer installation instructions.

Where primer is specified, the primer must be applied uniformly and completely over the surface. When a thickness of dampproofing coating is specified. The inspection records should show that the thickness was measured including the results.

Treatment of joints, with or without fabric, should be watched closely as they are often the weakest part of the treatment.

Application rates of sealant are to be checked and recorded.

As a final precaution, don't destroy the usefulness of the treatment by allowing careless backfilling methods that will tear, punch holes, or scrape off the fabric and sealant.

908 CONCRETE CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS

Curb and gutter serves two purposes, providing a conveyance for storm water and as a means of channeling traffic. Vertical curb may also serve as a barrier to low speed traffic. The type of curb shown on the plans should not be changed without consulting the designer.

Curb and gutter serves to convey stormwater to inlets, catch basins, storm sewers, and ditches. Paved streets with curbs sometimes serve as storm water channels. Both proper design and construction are required for the curb and gutter to function properly. Poor construction may result in areas which pond water, resulting in a potential safety hazard. Areas where this frequently occurs are at grade intersections especially in radii and valley gutters.

Curbs serve as a means of channeling traffic at intersections, ramps, traffic islands and medians, and delineating the limits of the traveled way to prevent the encroachment of motor vehicles onto sidewalks, medians, and refuge areas. Curbs also serve as an effective means to control driveway entrances. It is always good practice to consult with the property owner before final location of the depressed curb driveways. Minor adjustments to the size and locations of driveways to suit the property owner are acceptable as long as safety standards and local ordinances are not violated.

It is very important for the engineer to study the drainage conditions on any project where curbs will control or have an effect on drainage. This study should be made prior to the start of any grading work, as it may be necessary to make minor alterations in grades or minor changes in elevations of inlets to catch basins, culverts, etc., in order to assure efficient drainage. The engineer and surveyor are cautioned that two particularly troublesome areas are drainage through turnouts and areas where the curb is on the high side of super-elevated portions of the roadway. The areas behind and between curbs and right-of-way line should be checked to assure drainage flows to a drain structure.

Finished appearance is of great importance in the construction of curbs, gutters, sidewalks and driveways as they are seen by motorists and pedestrians. Good alignment, grade, and finish are essential. Clean, straight forms, in good condition, are necessary to achieve a quality product. Flexible radius forms should be used on curves. Forms should be properly staked and braced.

The operations of mixing, placing, and consolidating the concrete should be coordinated with the finishing operations so that the pour operation does not get too far ahead of the finishers. The use of too much water while finishing, e.g. sprinkling or spraying additional water on the surface, may make for a good initial appearance, but in a few years, traffic and run-off will wear away the thin, weak layer of paste on the surface that now has an excessive water-cement ratio. This is often difficult for the inspector to enforce due to poor past enforcement, but it must be done. In areas where freeze-thaw is of concern, such surfaces will delaminate within only one or two winters.

The inspector should not accept concrete that has been retempered or concrete that has been in the mixer longer than the time allowed by the specifications unless the use of a hydration stabilizing admixture has been approved and is included in the mix design. Since the specifications do not require vibrating concrete used in curbs and gutters, spading along the forms is necessary in order to work the coarse aggregate away from the faces, thus avoiding honeycombing.

Curing should follow closely behind the finishing operations, in accordance with the specifications. The application must be uniform and without discontinuities.

Concrete placed during cold weather including near-freezing temperatures should be properly covered and insulated to prevent fresh concrete from freezing. Even if freezing temperatures are not expected, evaporation can continue to lower the temperature of the concrete resulting in frozen concrete.

Areas of curb that are low must be augmented with fresh concrete, not paste or grout. Under no circumstances are these materials to be poured on the curb and gutter surfaces as an added layer for finishing purposes.

The top, front face, and flow line of curb shall be tested with a straightedge during the finishing operations. Documentation of the fact that such testing has been done will be made in the inspector's diary. The stationing of the section tested, the date and the results should all be included in such documentation. Each such entry is to be signed by the inspector. The contractor is required to take whatever corrective measures are necessary to produce curb and gutter that will completely conform to the specifications.

Scoring of sidewalks to create weakened planes and control cracking should be in accordance with standard drawings. Expansion joint material should meet the specifications and should be placed in accordance with the standard drawing. Special attention should be given to the scoring not only in sidewalk, but also curb and gutter. Good joints are important. It should be noted that Standard Drawing C-5.20 requires a broomed finish on sidewalks.

It is crucial that the construction of sidewalk ramps conform to the Standard Drawings. The inspector should pay particular attention to slope requirements guaranteeing that the ramp is navigable by a disabled individual. Locations which tend to be problematic are intersections in which signal poles, traffic signals, or fire hydrants are located immediately behind the sidewalk, potentially preventing the sidewalk ramp from maintaining the desired slope. Ramp grades must conform to the American Disabilities Act (ADA) requirements. If the ramp cannot be built as shown on the plans then contact the designer.

Reconstruction of driveways are often constructed with accelerated or high early strength concrete mixtures. These mixtures are very susceptible to excessive drying due to the increased heat of hydration that occurs during curing. These mixtures are also susceptible to shrinkage cracking due to increased cement/paste content. Therefore, for large driveways or any slabs that may be placed, it is imperative to consider the need for control joints, and both proper finishing and curing is essential for the longevity of the concrete.

Inspection Guidelines For Concrete Curb, Gutter, And Sidewalk:

- Has all soft or unsuitable subgrade material been removed and replaced to a depth of at least six inches below subgrade?
- Has the subgrade material been thoroughly compacted and tested to 95 percent at a depth of six inches before placing concrete?
- Have the subgrade and forms been watered ahead of placing concrete?
- When Portland Cement Concrete Pavement (PCCP) is to be constructed adjacent to the curb and/or gutter, has the pavement been placed prior to the construction of the curb and/or gutter?
- When the curb and gutter are adjacent to asphalt concrete pavement, does the curb and gutter have 2-inch contraction/expansion joints placed every 15 feet?
- Are the fixed forms of good appearance, shape, strength, rigidity, smoothness of surface and set to the depth equal to the full face height of the curb and/or to the full depth of the sidewalk?
- Have the forms been set to the correct dimension, grade, slope, ADA compliance, and adequately staked as to prevent movement during concrete placement.
- Does the slope of the gutter match the cross slope of the roadway?
- Have contraction/expansion joints been constructed every 60 feet and at all radius points, driveways and structures?
- When the curb and gutter are adjacent to PCCP do the joints match the PCCP joints?
- Are control joints properly formed and do sidewalk joints match with the adjacent curb at the required intervals per the plans or Standard Drawing C-05.20?
- Is the correct concrete mix being used in accordance with Section 1006.
- Has concrete been properly consolidated, and has finishing mortar been worked to the surface of the sidewalk?
- Did the finishers refrain from sprinkling/spraying additional water on the surface of the fresh concrete?
- Has the concrete surface of sidewalks been struck off with a float, troweled smooth, and then given a final fine brush finish?
- Have any electrical or irrigation sleeves running under the curb and gutter been identified and marked with an “S” on the top of the curb and the locations noted in your diary?

- Has the top surface, front face, and flow line of the curb and gutter been straight edged and the results documented in your diary?
- Has the sidewalk slope and surface tolerances been checked with a straight edge and documented in your diary?
- Has the all exposed concrete surfaces, including the front and back faces of curb and gutter, been properly cured in accordance with Section 1006-6.01?
- Has the exposed surface of fresh concrete been protected from freezing during cold weather?
- Does the finished product give a good appearance?

909 SURVEY MONUMENTS

A section line monument that has been disturbed by construction activities shall be re-established by the contractor, following the procedures in the Manual of Surveying Instructions, U.S. Department of the Interior, Bureau of Land Management. Applicable statutes and standards set forth in Minimum Standards for Land Surveying in Arizona, Arizona State Board of Technical Registration, shall also be followed. Monuments re-established shall be recorded in the Office of the County Recorder, and a copy of the Corner Recordation documentation shall be submitted to the Resident Engineer within five working days of recordation.

The contractor is responsible for locating and properly referencing the locations of the monuments so that the monument can be constructed with reasonable accuracy. Contract survey crews, as part of the verification process, shall locate and make ties to all located Section Line monuments and roadway monuments in the vicinity of the proposed work.

Frames and covers shall be cast iron and shall conform to the requirements of Subsection 1004-6 for Gray Iron Castings. The Department will furnish the brass caps for the survey monuments.

Normally excavation for the monuments will be made at the location and to the depths designated. When locations are changed, the as-built plans and the field books must show all the necessary details of the new location and a note explaining the reason for the change in location included. The monument will then be set as shown on the standard drawings, and the earth tamped into place.

910 CONCRETE BARRIERS

Three methods of constructing barriers are allowed under the specifications:

1. Cast-in-place by slip form or extrusion
2. Cast-in-place by fixed form
3. Precast

The most common method where large quantities are involved is the slip form system. Shorter runs of barrier are commonly cast in place utilizing fixed forms or are precast sections.

Whichever method is used, the final appearance will be influenced by the foundation. The inspector will need to exert the greatest part of their effort towards getting the contractor to prepare the foundation for the barrier or the grade the slip-form will ride on so that smooth horizontal and vertical lines will result.

The placing of concrete barriers on new bridges may not precede the release of falsework. Concrete barriers and barrier transitions to be constructed on bridges can only be constructed by fixed form, cast-in-place methods.

If at all possible, the Engineer should inspect work that has been done by the equipment to be used. By inspecting previous work any shortcomings can be discussed with the contractor and corrective measures agreed on. There have been problems in the past with vertical cracking of slip-formed barrier. In some cases the problem was never completely eliminated but the condition has been eased by attention to the rate of travel, maintenance of the proper concrete level when feeding the machine, properly operating vibrators, proper cure, and fine tuning the concrete mix.

The alignment of the barrier is very important and project personnel should be familiar with the tolerance requirements of the specifications. If difficulties are experienced by the contractor in providing an acceptable product, then the Engineer should take steps to correct the problem or stop work until the contractor can provide a product within the allowable tolerances. Barrier that has an unsatisfactory alignment which cannot be corrected to the satisfaction of the Engineer should be removed.

Cast-in-place forms are usually made of metal and need to be inspected for dents, bends, or any other defects that would be detrimental to the appearance of the finished barrier. Precast barrier sections will probably be inspected at the supplier's plant. As with any precast item, it is good practice for the Engineer to inspect finished work at the plant early in the production run. If the jobsite inspection shows cause for rejection, this can be resolved with the least disruption and expense to all parties if done before installation. The fact that precast barriers were inspected and accepted at the plant does not mean they must be accepted on the job if they are defective.

Joint sealant is used in all three types of barrier but the time of application and sealing procedure varies so it is important that the inspector is aware of the provisions for the particular type of barrier and the particular project.

911 RIGHT-OF-WAY MARKERS

Right-of-way markers consist of the furnishing by the contractor of all materials, except the brass caps, and installing right-of-way markers and reference markers in conformance with the Plans, applicable statutes, and procedures per the statutes and standards set forth in Minimum Standards for Land Surveying in Arizona, Arizona State Board of Technical Registration, shall also be followed.

Considerable care should be taken in setting right-of-way markers and survey monuments, as they become permanent control points for future survey work.

Right-of-way markers are set in cast-in-place concrete. The Department will furnish the brass caps for the markers and after completion of the monument the contractor will establish the survey point on the marker.

The reference markers are painted, lettered, and installed as shown on the plans or as directed.

Normally, the Engineer will furnish the contractor with a list of required information to be painted on the reference markers. The stations should be determined and established by the contractor as soon as possible.

The same precautions mentioned in Section 909 for survey monuments should be observed when staking for right-of-way monuments.

912 SHOTCRETE

Shotcrete is a pneumatically placed concrete mix that is also commonly called gunite. Shotcrete is a very useful and versatile method of paving flat slabs, vertical walls, and the entire gamut of slopes and shapes between. It is especially suited for constructing warped surfaces around structures. It has been used to construct inlets and outlets to culverts for the purpose of improving the efficiency of the structures. It may also be used successfully to preserve and protect or to enhance the appearance of a concrete wall or other structure providing the concrete is firm and reasonably sound. Construction costs, particularly on curved surfaces, are reduced because complex forms are not normally required. The equipment used is mobile and therefore usable in areas where it might be difficult to operate other types of equipment.

912-3 Construction Requirements

Slopes that are to receive shotcrete are best constructed by overbuilding the fill material to allow for compaction past the limits of the slope grading, then trimmed back to the desired grade. The exposed surface must be kept moist to reduce sloughing during construction operations.

The subgrade must be finished accurately to aid in maintaining uniformity in thickness. The subgrade must be kept damp but not overly saturated in order to avoid the moisture being drawn out of the shotcrete. The areas upon which shotcrete is to be placed are to be checked to see that they have been properly graded and compacted and that joints, wire mesh, side forms, and weep holes have been provided where required.

Welded wire fabric is usually specified for reinforcement. It will be designated in the following manner, 6 x 6 - W1.4 x W1.4, which means a 6-inch longitudinal by 6-inch transverse wire spacing using wires having a nominal diameter of 0.134-inch and a cross-sectional area of 0.014 in^2.

Specifications for wire fabric are to be found in AASHTO M55.

Wire mesh reinforcement (a.k.a. mat) must be held in its planned location prior to the shotcrete placement, proper positioning and securing of the wire mesh is critical. The mat should be adequately supported and secured to prevent appreciable and permanent deflection under the impact of the mortar during placement. Degradable or moisture transferring materials such as lumber or steel chairs should not be used in elevating and securing the mat, it is preferable to utilize plastic rebar chairs or concrete dobies. Too often contractors will attempt to skip this process by not supporting the mat and simply pulling the wire mesh up through the fresh mortar, This method should not be permitted, too often the mesh remains on the subgrade, in which the reinforcement is ineffective and is subject to rusting.

The success of shotcrete construction depends on having proper equipment, a satisfactory mix, and an experienced operator on the nozzle. An experienced nozzleman can get the best results with the least amount of rebound and filling in of low areas. Uniform pressures are necessary at the mixing tank, on the waterline and at the nozzle. Leaky lines or too long a nozzle line can have adverse effects on the pressure system. Where feasible, the equipment should be moved along the work rather than to use long hoses.

Rebound material may not be reused. The thickness shall be checked frequently. The placing of gauging wires aids in obtaining a uniform thickness and true surface.

Precaution is necessary to see that shotcrete is never subjected to hydrostatic pressure on the underside or backside. Paved slopes should have a cut-off wall at the top so that surface water can be diverted away from the paved slope where feasible. Weep holes, properly placed and spaced, with the proper filter material, are helpful in avoiding failure from hydrostatic pressure.

912-3.06 Quality Control Testing

All materials used to manufacture shotcrete shall be sampled and tested as prescribed for use in concrete.

The specification gives detailed requirements for making shotcrete test specimens. It is important to note that the test method calls for coring a test panel. The test panel is made by shooting the shotcrete onto a flat surface, then trimming the edges back to make the correct sized panel. Cylinders are not used with shotcrete.

912-3.09 Curing

Curing has been neglected in some cases because it was thought that curing was not necessary since the shotcrete does not carry a load and does not need strength. Curing is necessary for the prevention of cracks and to assure a hard, weatherproof surface.

Curing should be performed by one or more of the methods prescribed in the specifications. If the liquid membrane method is used, the inspector should assure himself that the required amount of material is being used. Due to the normally rough surface texture of shotcrete, it will be necessary to apply the cure from multiple angles and use a heavier application of curing material than that prescribed by the specifications in order to obtain complete coverage of the rough textured surface.

Due to the tendency of the compound to leave extra material on the side of the irregularities opposite the nozzle of the applicator, the second application should be applied from the opposite direction from the first application where feasible.

912-6 Records

The inspector should record the square yards of area covered with shotcrete within their diary each day with the following information; mix design code, type of equipment, length and size of hose, pressures, being utilized. Additional information such as operational problems affecting the quality of the work, any shutdowns, reasons for shutdowns, such as breakdown of equipment, lack of material, insufficient grade, or other reasons should also be noted.

The record must also show that the shotcrete being used meets the applicable specifications. A mix design is to be furnished by the contractor and verification is needed that the designed mix is being produced.

Temperature records are to be kept, especially when temperatures are close to the specification limits. Whenever air temperatures reach 50 degrees F, it is necessary to be alert to the possible need for a shut down of the work and/or protective action.

A record of the application rate of curing material should be documented in the inspectors diary.

913 BANK PROTECTION

The area designed to receive bank protection should be studied to see that the design is proper and adequate to meet field conditions. One area of scrutiny should be the direction of flow. Water should be directed toward the center of the streambed in order to avoid losses of property or structures downstream. Do not hesitate to recommend extension or modification of the riprap if there is doubt concerning the adequacy of the plans design.

Riprap will be one of the types specified on the plan, and described in Specification 913 and in the standard drawings. Often the size of riprap is designated as D50, which means the effective size of rock would be where the line crosses 50% on the grain size distribution curve. In other words, D50 is the median size of rock in a mix where 50% of the material, by weight, is finer particles. The purpose of riprap is to prevent erosion, so considerable care should be taken for proper placement of each section.

While riprap is designed and built to perform a very important function, the Resident Engineer should not lose sight of the need to make each installation pleasing to the eye. The cross section should be uniform and the lines and grades should be in reasonably close conformity with the standard drawings.

The Construction Standard Drawing, C-17.10, C-17.15 and C-17.20, depicts 9 different types of rail bank protection. Types 1 through 6 are all similar in design. The major difference is the length and spacing of the rails. Types 4, 5 and 6 are specifically designed to protect banks at bridge abutments.

When constructing types 1 through 6, rails should be driven as specified in the standard drawings. Wire mesh should be securely fastened to the rails, placed in the trenches and laid on the slopes. The wire mesh must entirely enclose the rock backfill. The rock backfill should then be placed so as not to disturb or displace the mesh or rails. The completed rock fill should be to the lines and grades specified and should be pleasing in appearance.

Type 7 and 8 are similar in design and are usually used for directing flow of water to a bridge. Type 9 is used to cause deceleration of the stream and deposition of aggregate particles principally behind the bank protection.

It should be noted, riprap and bank protection designs provide for the rock, etc., to be placed below the stream level. This portion of the design is crucial since most failures in riprap occur as a result of storm water undercutting the rock protection which leads to eventual collapse.

Special care should be exercised to construct all types of protection at the proper stream elevation. Inspections downstream should be made for possible problems which could later contribute to scour or silting conditions. If problems are evident, a check with the Drainage Design Services is advisable before plans grades are changed.

The specifications say the rock shall be sound and durable which leaves a broad area subject to personal interpretation. It is advisable to have the District and, if needed, the Materials Section inspect rock sources proposed by the contractor. This inspection should be arranged for as soon as possible so that any testing or prospecting will not cause undue delay or expense.

It is important to maintain a uniform grading of dumped rock riprap. The uniform grading is necessary to assure proper filling of the voids in the riprap. Properly filled voids will lend stability by keying the mass and to protect the underlying filter material.

It is also important that filter fabric be installed properly. Holes in the fabric will permit fine particles in the bank to erode and pass through the riprap. The protected structure can fail as the bank erodes away even if the riprap remains intact. A layer of bedding material is required to protect the fabric when the maximum rock size is greater than 18 inches.

The specifications call for two 5 ton samples of the graded rock to be used in judging the acceptability of gradation for dumped riprap and slope mattresses; 500 lbs is required for riprap that is to be grouted, wire tied, placed in gabions, or as rail bank protection. Frequent reference to the sample rock pile will help to maintain uniform grading. Uniformity of grading is especially important in untied or ungrouted riprap. These types of riprap need

good distribution of the coarse and fine rocks to provide interlock and keying which gives the riprap enough rigidity to resist erosion.

The specifications also require the specific gravity of the rock used for riprap to be at least 2.4, therefore riprap should be sampled and tested. This is important to ensure the riprap satisfies design assumptions to provide adequate protection. If necessary, the contractor must break down and provide material sized between 3 inches and the No. 4 sieve for the Department to perform such testing.

For grouted riprap, the specification states that retempering will not be permitted. Retempering is defined as adding water to grout to restore workability. Although referred to as grout, the grout used for riprap must be a very durable material and meet the requirements in 913-2.01(D).

The use of sacked concrete or soil-cement also includes important requirements to ensure performance; equally important for all bank protection is making sure the contractor complies with all installation and any other construction requirements.

915 TEMPORARY SILT FENCE

The temporary silt fence should be installed in accordance with the SWPPP plans and Special Provisions after being reviewed by the Resident Engineer with the inspectors. The inspector should know the type of materials used when constructing a temporary silt fence. Some silt fence geotextile fabric will deteriorate when exposed to ultraviolet light. The standard specifications and or the manufacturer recommendations should explain requirements for storage and handling of the geotextile fabric used in the silt fence.

Close inspection is required to ensure that construction requirements are met. The geotextile fabric at the bottom of the fence must be buried to an appropriate depth in accordance with the plans and specifications. The appropriate depth will keep flow from passing underneath the fence. The posts, wire supports, and fabric post attachments must be in accordance with the plans or special provisions. Any geotextile fabric that is flawed such as a hole, rip, etc. will be rejected by the inspector.

Guidelines For Inspecting Temporary Silt Fence:

- Do the materials conform to the plans and specifications, and are the materials certifications available for those items requiring them?
- Is the geotextile at the bottom of the fence buried to the correct depth?
- Are posts spaced at the proper intervals and have the posts been driven to the proper depth?
- Is the geotextile fabric fastened with the proper attachments and in the proper locations?
- Is the wire support used, and placed properly?
- Will the temporary silt fence be able to handle the expected stress from sediment loading?
- Once installed, the silt fencing should be inspected following every rain event; no matter how small, and during the scheduled SWPPP inspections.

916 EMBANKMENT CURB

The embankment curb is constructed of concrete, as shown on the plans and the standard drawings. Its purpose is to contain and direct the run-off water from the pavement surface so that it may be removed from the roadway at selected locations by means of spillways or down-drains.

Every effort should be made to place embankment curb to true lines and grades without humps and sags and to produce a mixture which will require little or no hand finishing.

The most common method of concrete embankment curb construction is by use of the slip form. Curbs however, may be constructed by the use of conventional forms.

The concrete specifications have been modified to fit the special conditions found in embankment curb construction. Standard Specification 916 contains the detailed requirements for concrete used in embankment curb.

Some curb extrusion machines cause trouble with slumping, tearing, irregularities, or other unacceptable results. Usually the machine can be adjusted or modified, or the concrete mix can be adjusted, but sometimes it may be necessary to discontinue use of the machine if it can not construct the curb according to the specifications.

917 EMBANKMENT SPILLWAYS, DOWN-DRAINS, INLETS, AND OUTLETS

Spillways or down-drains for carrying the water collected by the curb from the roadway surface will be constructed at the locations shown on the plans or as directed and in accordance with the Standard Drawings (C-04.10 through C-04.50) and the Standard Specifications. These types of down-drains must be practically waterproof to prevent erosion of the fill. Consequently, if there is any suspicion that it is not waterproof, a test should be made by pouring water through the inlet to test for leakage. If leakage occurs, the point or points of leakage should be patched with hot-poured, or cold-application joint sealant (Subsection 1011-4) as directed by the Resident Engineer.

It is important that drains are carefully located to assure there will be no standing water on the roadway. Standing water can be a traffic hazard or may damage the roadway by seeping into the base and subgrade.

922 UTILITY CONCRETE FOR MISCELLANEOUS CONSTRUCTION

Utility concrete is used when high strength is not needed and small quantities are used at one time so that elaborate testing and inspection are not justified.

Specifications for materials are the same as for other types of concrete found in Section 1006. The minimum cement content is 470 pounds per cubic yard. The discussion on concrete in Section 1006 should be read for guidance in judging whether the contractor's materials and methods will be satisfactory. Section 1006 should not be considered to be setting out requirements but only as a guide to assist in recognizing areas where problems may develop.

If approved by the Engineer, the contractor may substitute commercially available sacks of redi-mix concrete, suitable for the intended purpose. Should such substitution be approved, the cement specified herein and the requirements of Subsection 922-2 shall not apply.

Although minimal inspection is required, it is necessary to look at the contractor's batching and mixing equipment and procedures. If the contractor's methods are not acceptable, a written notification is required. The Resident Engineer will need to use firmness and ingenuity in dealing with the contractor under the concept of recognized practice.

The contractor has to furnish an acceptable product and choose the slump range and aggregate size. However, the Resident Engineer is required to review and approve the proposed mix prior to its incorporation into the work.

Although the contractor chooses the aggregate size, the grading must conform to AASHTO M43. Mixing can be done manually at the job site as well as plant or truck mixing as long as the Resident Engineer approves. A great amount of leeway also exists in the method used to proportion the materials; again, only the Resident Engineer’s approval is needed.

When reviewing the contractor's mix proposal, a rule of thumb guide for aggregate having a fineness modulus of from 2.60 to 2.90; is when 1 to 1-1/2 inch aggregate is used, the fine aggregate should be 40% to 45% of the combined fine and coarse aggregates. The total water needed to provide a 3 inch slump will be about 7 gallons per sack of cement.

925 CONSTRUCTION SURVEYING AND LAYOUT

Contractor Survey

On those projects that are so designated, the contractor will be responsible for providing construction surveying. This will require competent personnel to perform survey calculations and necessary field documentation such as field books, cross section books, and earthwork quantities. The Resident Engineer should insure that this work is performed under the direction of a Registered Professional Engineer/Surveyor employed by the contractor.

The Department will provide either traverse or control points for establishing an accurate construction centerline and will establish benchmarks adjacent to this line for the proper layout of the work as described herein. Control points will be located on centerline at the beginning and ending of the project, and at all points of curve (P.C.), points of tangent (P.T.), tangents to spiral (T.S.), spirals to tangent (S.T.), and angle points. On long tangents, additional points will be provided for continuity of line.

Traverse points, when provided, will be as follows:

For horizontal control, the Department will run a traverse from which construction centerline can be established. The control points, delineated by iron pins, marks in concrete, or similar devices, will be located to minimize the likelihood of their destruction during construction activities. Coordinates of these points and/or ties to construction centerline will be provided.

For vertical control, the Department will establish benchmarks the entire length of the project at horizontal intervals not to exceed 2,500 feet.

These control points will be properly referenced and their location documented for future reference. The contractor should then be provided with this information and physically shown their locations. At this time, the contractor should be made aware that it is their responsibility to preserve these points for the duration of the project.

Copies of recorded Results of Survey, Record of Survey, Corner Records, documents, maps and plats shall be submitted to the Engineer within ten working days after recordation at the Office of the County Recorder. Copies of all field notes, computation sheets and calculations that relate to the boundary surveys shall also be submitted to the Engineer within this time frame.

Before beginning any construction, the contractor must submit an outline detailing all survey activities for the project and the sequencing of these events. Section 1150.00, contractor Construction Surveying, of this Construction Manual should have been used by the contractor in preparing the outline. The Resident Engineer should thoroughly review this plan to ensure that it is realistic, provides the scope of work that is required, and can be monitored by project personnel.

When the survey plan is approved, the contractor should then check the accuracy of the control work established by the Department, to their satisfaction.

Once construction begins, the Resident Engineer should assign a survey supervisor to monitor the activities and documentation of the contractor's survey personnel. Conflicts can easily be resolved if there is cooperation between the contractor and ADOT personnel in this area. The monitor should not actively get too involved with this work, but should be aware of the various survey activities and be available for consultation if the contractor requests it. The monitor should also be checking for suspected problem areas or deficiencies in the operations. If there are serious survey problems and inconsistencies, the Resident Engineer should be made aware of them, and actions taken to correct them. Serious problems may require restaking at the contractor's expense.

Survey Control for Pavement Marking

It is important that pavement markings be accurately laid out prior to their application on the roadway.

At the start of the project, when the contractor submits the schedule of payment for the lump sum Construction Surveying and Layout item, the R.E. should ensure that survey control and layout for final striping is included. If the schedule fails to include a reasonable percentage for this item, the R.E. should reject the schedule and require the contractor to resubmit a corrected version for approval. The intent is to ensure that the contractor has planned for the necessary resources to complete the final striping requirements for the project.

A minimum of two weeks prior to any paving activities, the contractor, the contractor's survey and pavement marking subcontractors, a representative from Regional Signing and Striping and the Resident Engineer will hold a pre-activity meeting in accordance with the project special provisions, to discuss the survey control for the applications of all temporary and permanent striping. At the meeting the contractor shall provide a written pavement marking layout plan, including provisions for survey control for the final pavement markings, that is satisfactory to the Engineer. The plan must meet the minimum requirements for survey control and layout of the temporary and permanent striping as defined in Standard Specification 925-3.01.

The plan shall include timeframes that ensure layout is completed in a timely manner. It is the intent that the contractor's survey and pavement marking subcontractors concur with the provisions of the written pavement marking plan. When applicable, the plan shall also include the contractor requirement to coordinate the survey layout of projects with no-passing zones with the ADOT No Passing Zone Crew. This contact (phone number provided on the project plans) should be made at least five working days before placement of the applicable pavement marking.

The liability for the proper layout and placement of the striping is clearly the contractor's. If done incorrectly, the Engineer has the authority to require that it be redone correctly at no additional cost to the Department.

926 - 927 ENGINEER'S FIELD OFFICE AND FIELD LABORATORY

When the plans or special provisions require it, the contractor may be responsible for furnishing adequate facilities for the Resident Engineer to use as a construction field office and a field laboratory. The Standard Specifications or Special Provisions will contain a list of what services and facilities are included in this requirement.

The Resident Engineer will designate the location of the field offices and the contractor will provide and maintain all utilities necessary to make this office fully functional prior to commencing any work activities.

The Resident Engineer should ensure that all required permits are obtained by the contractor and that provisions have been made to keep the facilities fully functional for the duration of construction activities.

928 GROUND-IN RUMBLE STRIP

Rumble strips are indentations in the surface of a pavement which serve the purpose of alerting a driver that they are leaving or drifting away from the designated driving lane. They are usually placed on both the inside and outside shoulders of rural high speed divided highways and on the shoulders and centerline of rural undivided highways.

The Traffic Guidelines and Processes (TGP) Sub-section 480 Continuous Longitudinal Rumble Strips provides the guidelines for the installation locations and exceptions. Traffic Standard Drawing M-22 contains information on the dimension and tolerances for the rumble strips.

The plans should identify the specific rumble strip locations and exceptions. There is careful consideration during design with respect to proximity of current and future urban areas, residences, shoulder widths, bicycle accommodations, pavement conditions, intersections, driveways, etc. Rumble strips are not placed on structures, approach slabs, or weigh-in-motion slabs. If the locations and exceptions are not clear on the plans or if field conditions warrant a change to the rumble strip locations, contact Traffic Engineering Group for review and approval prior to installation.

It is important that inspectors who are assigned to this portion of the work assure that the equipment used to construct the strips is adequate and conforms to the specifications. Rumble strips shall be constructed by milling or grinding; indentations formed by a roller on newly paved asphalt are not acceptable. This equipment should be equipped with an approved guide easily visible by the operator. The right type of equipment allows the contractor the capability of providing the required alignment and uniformity.

929 GEOSYNTHETIC REINFORCED SOIL (GRS) RETAINING SYSTEMS & MECHANICALLY STABILIZED EARTH (MSE) WALLS

Geosynthetic or geogrid reinforced retaining systems may be included in the project where conventional retaining structures, e.g. retaining walls, abutments, would typically be constructed, and GRS is often utilized for Accelerated Bridge Construction (ABC). Although GRS & MSE walls have several features that are very similar such as the geogrid;, wall facing blocks, and pins, connecting subsequent courses of wall facing and to secure geogrid, there are several differences between GRS and MSE wall construction. Inspectors should also be careful to not assume the process of installation of geogrid for GRS and MSE walls is the same as that for reinforcement of roadway, GRS and MSE walls are structural whereas roadway geogrids are purely geotechnical; the products themselves, the design process, and the installation are NOT the same and treating GRS and MSE wall construction the same as geogrid-reinforced road construction may result in instability in the form of excessive vertical and lateral displacements. Likewise, geogrid for structural applications may not be appropriate for use as roadway geogrid.

Both GRS and MSE walls include reinforcing geogrid specifically designed to control and stabilize slope failure mechanisms that would otherwise result in failure of the structure. GRS systems require closely spaced layers of geogrid, while MSE systems use metallic grids of welded wire or other straps spaced much farther apart than GRS. In both instances, the geogrid is designed (strength, length, and vertical spacing) based on slope stability analysis to intercept the potential failure planes associated with the retaining system. The primary difference between these two systems is that MSE walls may be constructed of backfill material that is not a manufactured product, could perhaps even be natural soil of reasonable quality, and typically always includes a drainage system to prevent the occurrence of hydrostatic pressure due to saturated soils, however, GRS construction utilizes highly engineered, manufactured (crushed) aggregate that is free draining, the quality of which must be tightly controlled during production and construction.

MSE walls are designed based on the specific mechanical properties of the backfill material anticipated or required to be used for construction; each MSE wall is different, has a different design, and different requirements. Therefore, it is vital that the materials used to build the MSE wall meet the requirements for all properties specified without exception. The backfill material used for MSE walls will be sampled and tested in accordance with the project special provisions.

For GRS, the design is general in nature, but also relies on the materials used to build the structure meeting the requirements specified without exception. The design is not specific to a particular aggregate material, however, the aggregate must be manufactured to meet the requirements specified to ensure the structure performs as intended. Because the engineered reinforced aggregate backfill material does not lend itself to density testing the compaction of the aggregate is specified by the method specification.

Geogrid for GRS and MSE walls is accepted based on certificate. There is no category for this type of geogrid on the Department's Approved Products List (APL). Rather, such geogrids may be specified by product name and manufacturer as part of the system designed for the project in the special provisions. The special provisions may reference a specific type or category of product or provide material properties which the selected product must meet. The specific product to be used must have been evaluated by the National Transportation Product Evaluation Program (NTPEP), and the associated data for which must appear in NTPEP's online Datamine. All required information must be on hand and the product confirmed adequate prior to installation. Sampling is typically not required unless stated in the project special provisions, or the quality of the material is suspect or appears defective.

Geogrid Manufacturer handling and installation instructions must be strictly adhered to which may include limiting exposure to sunlight as well as how the geogrid may be lifted, moved, and placed.

There are many different types of MSE retaining wall systems. Review the installation instructions and specifications for the specific wall system being installed. Many systems have specific requirements for shims and spacers, wedges, batter, leveling pads, panel alignment, panel storage, reinforcement storage, filter fabric and

joints, copings, compaction equipment near the wall, protecting the wall from stormwater damage during installation, etc.

After becoming familiar with the requirements in the project's special provisions, the key construction/installation steps which the inspector should observe to ensure correctness include:

- Preparation of a sound, level, and adequately compacted base or cast in place concrete leveling pad upon which the first course of wall facing will be installed, any deviations will become more pronounced as subsequent courses of block are placed.
- Preparation of a flat, level, moisture conditioned and compacted ground surface upon which geogrid reinforcement and structural aggregate will be installed.
- Where drains are required, drains must be completely wrapped in filter fabric prior to placement of any required drainage rock and/or backfill material.
- PVC should be stored and handled in accordance with the manufacturer's recommendations, to minimize ultraviolet deterioration from sunlight.
- Separation filter fabric, when required, must be installed between any drainage rock and other soils/backfill materials to prevent infiltration of soil into the drainage system.
- Verifying geogrid, block pins, and wall facing blocks are of the correct type; not sourced from multiple types or production lots not covered by the certifications.
- Placement of geogrid is such that the geogrid is kept taught at all times; the material must engage tension against the block pins and from structural aggregate / backfill as the material is placed.
- Structural aggregate backfill material MUST be placed beginning at the back of the wall facing and then by working away from the wall; not at end of geogrid and then pushed toward the wall face. Placing in the incorrect direction will induce slack in the geogrid, preventing it from engaging and mitigating slope failure stresses as intended.
- Compaction of the reinforced structural aggregate must adhere very strictly to the method specified including compaction equipment and compaction patterns. The stability of the system depends on the reinforced aggregate being adequately compacted with the proper equipment. Each lift must be confirmed to have been compacted per design standards.
- For MSE walls, lab proctors should be obtained when controlling compaction of backfill material. Do not use one-point field proctors for compaction control but only as intended when confirming consistency of backfill material.
- Block placement must retain the required vertical alignment. Plumbness of split-faced block should be checked on the back of the block; not the rough face of the block. Any corrections necessary must be made prior to the installation of subsequent courses.

REFERENCES AND ADDITIONAL INFORMATION

There are no references or additional information associated with this chapter at the present time.

ASSOCIATED FORMS

There are no blank forms associated with this chapter at the present time.