

DATE: July 31, 2013

TO: MAG Specifications and Details Committee Members

FROM: Peter Kandaris, Advisory Member

RE: Revisions to Section 340 – Concrete Curb, Gutter, Sidewalk, Sidewalk Ramps, Driveway and Alley Entrance – *Modifications to 7/10/13 draft*

Modifications to the 7/10/13 draft of the revised specification are attached. Comments received to date have been incorporated as follows (adds/mods shown in yellow highlights):

- Section 340.3.1 – Expansive soil testing has been changed to typical index test methods (sieve, PI, liquid limit). See attached documentation for new parameters. Expansive soil is now treated the same way as unsuitable soil (6" removal and replacement).
- Section 340.4.2 – Modified language to note curb/gutter contraction joints are to match adjacent *attached* sidewalks.
- Section 340.3.7 – Added language to note retooling joints as needed to prevent groove bonding.
- Section 340.3.7 – Contractor stamping is now noted to be placed on sidewalks and sidewalk ramps (not on curbs and gutters).
- Section 340.3.9 – Noted that sidewalk tolerance measurements are to done in all directions.
- Added modifications to Details 221 and 230 to change score marks references to contraction joints.

SECTION 340

CONCRETE CURB, GUTTER, SIDEWALK, SIDEWALK RAMPS, DRIVEWAY AND ALLEY ENTRANCE

340.1 DESCRIPTION:

The various types of concrete curb, gutter, sidewalk, sidewalk ramps, driveways, and alley entrances shall be constructed to the dimensions indicated on the plans and standard detail drawings.

340.2 MATERIALS:

Concrete shall be ~~class B unless otherwise~~ noted on the standard details. Concrete shall conform to the requirements of Section 725.

Expansion joint filler shall be ½-inch thick preformed bituminous material in compliance ~~comply~~ with Section 729, unless otherwise noted.

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

340.2.1.1 Color and Contrast: Detectable warnings shall contrast visually with adjoining surfaces, either light-on-dark or dark-on-light. Specific colors to be used shall be approved by the local jurisdictional agency prior to installation. Detectable warnings shall have integral color throughout.

340.2.1.2 Materials: Detectable warning materials shall be durable with a non-slip surface not subject to spalling, chipping, delamination, or separation. All detectable warnings shall be approved by the local jurisdictional agency prior to installation.

340.2.1.3 Attachment System: Detectable warnings shall be either placed in freshly poured concrete (wet-set) or recessed into pre-formed concrete. Detectable warnings using wet-set placement shall have an anchoring method that assures constant contact of the detectable warning bottom surface with the concrete as it cures, thus rendering the ramp a single monolithic structure. The thicker and heavier detectable warnings lowered into pre-formed recesses in the concrete substrate must demonstrate a firm fitting into metal reinforced frames without gaps along the edges that can channel water, sand, or debris. They must also be able to resist movement (i.e. sliding, rocking, or lifting) once in service. All attachment systems shall be approved by the local jurisdictional agency.

340.3 CONSTRUCTION METHODS:

Existing pavements and concrete that are joined by new construction shall be cut in accordance with Section ~~601~~336.2.2.

340.3.1 Subgrade Preparation: The subgrade shall be constructed and compacted true to grades and lines shown on the plans and as specified in Section 301. All soft or unsuitable material shall be removed to a depth of not less than 6 inches below subgrade elevation and replaced with material satisfactory to the Engineer. Removal and replacement of soft or unsuitable materials will be paid for as extra work.

When the Engineer determines that the existing subgrade consists of soils with questionable swelling characteristics, subgrade shall be tested in accordance with Table 340-1. The upper 6 inches of marginally expansive soils shall be compacted per Section 301.3 at a moisture content between 0% to 3% above optimum moisture per ASTM D698. Expansive soils shall be considered unsuitable and removed and replaced in accordance with the preceding paragraph. Alternate corrective measures may be submitted to the Agency by the Contractor or Permittee for review. The submittal must include recommendation affixed with the professional seal of an Arizona registered engineer

Table 340-1			
Description	Percent Fines (-#200 sieve) ⁽¹⁾	Plasticity Index ⁽²⁾	Liquid Limit ⁽³⁾
Non-expansive		< 15	< 25
Marginally expansive	> 20%	> 15 and < 30	> 25 and < 50
Expansive		> 30	> 50

(1) Tested in accordance with ASTM C117

(2) Tested in accordance with AASHTO T90 (wet prep per AASHTO T146)

(3) Tested in accordance with AASHTO T89 (wet prep per AASHTO T146)

~~the moisture content shall be brought as close as possible to the optimum required for compaction. This shall be done by the addition of water, by the addition and blending of dry suitable material or by the drying of existing material. The subgrade shall then be compacted to a relative density of 75% minimum to 85% maximum with 80% as ideal.~~

~~Material displaced in the Material removed for construction shall not be placed on the base and/or surfacing material already in place on the roadway nor shall the excavated material be placed in such a manner as to interfere with access to property or traffic flow in the street.~~

~~Existing concrete sidewalks and driveways which abut the new sidewalks and driveway entrances shall be removed to a distance required to maintain a slope as indicated by standard details or not to exceed 1 inch per foot where sidewalks are concerned. Sawcutting is required at the match lines and payment will be made under the respective pay items as provided in the proposal.~~

340.3.2 Formwork: Concrete curbs, gutters and sidewalks shall be constructed by the conventional use of forms, or may be constructed by means of an appropriate machine when approved by the Engineer.

If machines designed specifically for such work and approved by the Engineer are used, the results must be equal to or better than that produced by the use of forms. If the results are not satisfactory to the Engineer, the use of the machine shall be discontinued and the Contractor shall make necessary repairs at his own expense. All applicable requirements of construction by use of forms shall apply to the use of machines.

Forms conforming to the dimensions of the curb, gutter, sidewalk, sidewalk ramps, driveway, and alley entrance shall be carefully set to line and grade, and securely staked in position. The forms and subgrade shall be watered immediately in advance of placing concrete.

Forms shall be thoroughly cleaned each time they are used, and shall be coated with a light oil, or other releasing agent of a type which will not discolor the concrete.

340.3.3 Concrete Placement: The concrete shall be thoroughly spaded away from the forms so that there will be no rock pockets next to the forms. The concrete may be compacted by mechanical vibrators approved by the Engineer. Tamping or vibrating shall continue until the mortar flushes to the surface, and the coarse aggregate is below the concrete surface. The surface shall then be struck off and worked to grade and cross section with a float.

If machine placement is used, the machine shall place, consolidate and finish the concrete in one complete pass, requiring a minimum of hand finishing producing a dense and homogeneous section. A form shall trail behind the machine for such a distance that no appreciable concrete slumping will occur. Final finishing shall be as specified hereinafter.

340.3.4 Joints: Shall be constructed in a straight line, vertical plane and perpendicular to the longitudinal line of the sidewalk, curb and gutter, single curb, etc., except in cases of curved alignment, where they shall be constructed along the radial lines of the curve.

340.3.4.1 Expansion Joints: ~~Unless otherwise specified, expansion joints shall be installed at all radius points, at both sides of each driveway, at both sides of each alley entrance, at adjoining structures and at every change of depth in the concrete and shall provide for complete separation of adjoining structures. The maximum distance between expansion joints shall be 50 feet. Expansion joints shall be constructed in a straight line, vertical plane and perpendicular to the longitudinal line of the sidewalk, curb and gutter, single curb, etc., except in cases of curved alignment, where they will be constructed along the radial lines of the curve. Expansion joints shall be placed to match the joints of the adjacent concrete such as sidewalk to the curb and gutter or single curb, etc.~~

Expansion joints shall be constructed to the full depth and width of the concrete and shall match joints in adjacent pavement, sidewalk, curb or gutter. The expansion joint material shall extend fully through the concrete and one inch into the subgrade with the top of the expansion joint material one-quarter inch below the top surface ~~as depicted in Detail 230.~~ Expansion joint material shall be secured in place prior to placement of concrete. ~~Unless otherwise specified, all expansion joints installed against newly placed concrete, sawcut or other smooth surfaces shall comply with Section 729.1—Premolded Joint Filler per ASTM D1751, ½ inch, Bituminous Type. Expansion joints installed against existing uneven surfaces shall be per Section 729.2—Pour Type Joint Filler.~~

340.3.4.2 Contraction Joints: ~~Contraction joints, unless otherwise specified, the large aggregate in contraction joints shall be separated to either side of the joint for a minimum depth equal to 25% of the concrete thickness; the finished depth shall be a minimum of ¾ inch. shall be constructed in accordance with the standard details, and in a straight line and vertical plane perpendicular to the longitudinal line of the sidewalk, sidewalk ramp or curb and gutter, except in cases of curved alignment when they will be constructed along the radial lines of the curb.~~

Contraction joints in curbs and gutters shall match contraction joints in adjacent attached sidewalks.

~~Sidewalk or sidewalk ramp score marks, unless otherwise specified, shall be constructed in accordance with the standard detail.~~

340.3.5 Edges: All exposed edges shall be shaped with a suitable tool so formed ~~as to round the edges to a radius~~ having the shape as indicated on the standard referenced details.

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

~~340.3.6 Detectable Warnings: Detectable warnings shall be installed perpendicular to the direction of pedestrian/wheelchair travel and have a minimum width of 24 inches measured perpendicular to the edge of the roadway or rail crossing. The base surface of detectable warnings shall be installed flush with the adjacent walkway surface; the truncated domes shall extend above the walkway surface. The boundary between detectable warnings and the adjacent walkway shall provide a flush uniform surface that will not cause ponding of water nor present a tripping hazard. Partial domes at the edge of the detectable warning shall be made flush to match the base surface of the detectable warning. Detectable warnings installed on curb ramps shall extend the full width of the ramp depression.~~

~~Detectable warnings installed on sidewalk ramps shall modify the sidewalk concrete thickness at the detectable warning to provide a minimum concrete thickness of four-inches (4"). When detectable warnings are modules inset into the sidewalk ramp, the bottom surface of the sidewalk shall be lowered a distance equal to or greater than the module thickness to maintain the minimum sidewalk thickness. The sidewalk bottom surface shall have a minimum transition taper length of 12" between the thickened and normal depth sections of sidewalk. The detectable warning surface shall be located so that the edge nearest the curb line is 6 inches minimum and 8 inches maximum back from the face of curb.~~

~~Detectable warning surfaces for pedestrian at-grade rail crossings not located within a street or highway shall be installed on each side of the rail crossing, located as shown on plans. Detectable warnings shall extend the full width of the pedestrian walkway.~~

~~340.3.7 Form Removal and Finishing: The front face form shall not be removed before the concrete has taken the initial set and has sufficient strength to carry its own weight. Gutter forms and rear forms shall not be removed until concrete has hardened sufficiently to prevent damage to the edges. Special care shall be taken to prevent any damage. Any portion of concrete damaged while stripping forms shall be repaired or if the damage is severe, replaced at no additional cost to the Contracting Agency.~~

~~After the forms are removed, the joints shall be tooled and the surface finished with a float to remove all imperfections. As needed, retool joints after finishing to prevent groove bonding. In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The concrete work shall have a true surface; shall be free from sags, twists, or warps; have a uniform appearance; and be true to the lines, grades, and configurations indicated on the drawings.~~

~~Surfaces shall be light broom finished.~~

~~The Contractor shall stamp his the company name and year on all work done by him, on each end of the curb, gutter, sidewalk or sidewalk ramp constructed. The letters shall not be less than 3/4 inch in height.~~

~~340.3.8 Curing: As soon after the completion of the finishing operations as the condition of the concrete will permit, all exposed surface shall either be sprayed with a pigmented curing compound or sealed with a material conforming to Section 726. Curing compound shall be applied under pressure through a spray nozzle in such manner and quantity as to entirely seal all exposed concrete surfaces with a uniform film. The membrane shall be applied in two applications for a total coverage of 150 square feet per gallon. Concrete surfaces shall be kept damp until the curing compound is applied. Should the curing compound~~

seal be broken or damaged before the expiration of 10 days after the placing of the concrete, the break shall be immediately repaired by the application of additional curing compound over the damaged area. If due to weather conditions, materials used, or for any other reason, there is any likelihood of the fresh concrete checking or cracking before the curing operations, it shall be kept damp (not wet) by indirect fine spray of water until such danger is past, or until curing operations are started in the particular area affected. The need for adequate continuous curing is greatest during the first few hours after placement of concrete.

340.3.9 Tolerances: The face, top, back, and flow line of the curb and gutter shall not deviate in excess of 1/4-inch over 10 feet, as tested with a 10-foot straightedge or curve template, longitudinally along the surface. ~~Any deviation in excess of 1/4 inch shall be corrected at no additional cost to the Contracting Agency.~~

The surface of concrete sidewalk or sidewalk ramp in all directions shall not deviate in excess of 1/8-inch over 5 feet as tested with a 5-foot straightedge except for the 1/4-inch recess of the preformed material in expansion joints. ~~Any deviation in excess of 1/8 inch shall be corrected at no additional cost to the Contracting Agency.~~

All finished concrete elevations shall not deviate from the elevations shown on the plans, or indicated by typical sections or standard details referenced within the construction documents, by more than 1/2 inch.

When required by the Engineer, gutters ~~having a slope of 0.8 foot per hundred feet or less, or where unusual or special conditions cast doubt on the capability of the gutters to drain, they shall be water tested. Water testing shall consist of~~The Contractor shall establishing flow in the length of gutter to be tested by supplying and distributing water from a hydrant, tank truck or other source. ~~One hour a~~After the supply of water is shut off; and water has stopped flowing, the gutter shall be inspected for evidence of ponding or improper shape. ~~The work shall be deemed deficient if~~In the event water is found ponded in the gutter to a depth greater than 1/2 inch; or ponding extends onto the adjacent asphalt pavement; ~~the defect or defects shall be corrected in a manner acceptable to the Engineer without additional cost to the Contracting Agency.~~

Areas between elevations shown on the plans shall be straight graded or smoothly transitioned through a vertical curve in a manner approved by the Engineer or as otherwise indicated on the construction documents.

340.3.10 Deficiencies: Any section of the work deficient in depth or not conforming to the plans or specifications shall be removed and replaced by the Contractor at no additional cost to the Contracting Agency. Replacement or reconstruction shall be from joint to joint.

Concrete work that deviates in straightness as specified in Section 340.3.9 shall be removed and replaced.

Remove and replace gutters that exceed the ponding tolerance in Section 340.3. Grinding shall only be allowed if approved by the Engineer.

Remove and replace all work that exceeds the elevation tolerance in Section 340.3.
~~Finishing and Curing of the concrete shall be done in the manner specified in Section 505.~~

~~**340.3.1 Detectable Warnings:** The detectable warning surface shall be located so that the edge nearest the curb line is 6 inches minimum and 8 inches maximum back from the face of curb. Detectable warning~~

~~surfaces for railroads shall be located so that the edge nearest the rail crossing is 6 inches minimum and 8 inches maximum from the vehicle dynamic envelope.~~

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

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

340.4 BACKFILLING:

Unless otherwise specified the Contractor shall backfill behind the curbs, sidewalk or sidewalk ramps with soil native to the area to the lines and grades shown on the plans.

340.5 MEASUREMENT:

Concrete curbs and gutters of the various types shown on the plans and in the proposal, will be measured along gutter flow line through inlets, catch basins, driveways, sidewalk ramps, etc., by the lineal foot to the nearest foot for each type, complete in place. Measurement for curb terminations and transitions shall be included with the linear measurement of the various types of curb or curb and gutter as shown on the plans and in the proposal.

Curb and gutter type shall be based on the configuration of the final exposed surfaces. The increased curb and gutter depth required at valley gutter aprons or driveways shall not be measured as a separate pay item; any additional Contractor cost shall be included in the unit cost associated with the valley gutter, driveway or other associated item.

~~Concrete sidewalks, sidewalk ramps, driveways, alley intersections, valley gutters and aprons will be measured to the nearest square foot complete in place. When concrete sidewalk, sidewalk ramps, driveways, alley intersections, valley gutters, and/or aprons are cut during trenching operations, the square foot measurement for payment will be in accordance with Section 336.~~

Detectable warnings shall not be measured for payment. Detectable warnings are considered integral to the walking surface that they form a part of and the cost is included in the related pay item.

Curb ramp installations shall be measured as complete installed units and shall include the ramp curb and the walking surfaces between the ramp curb and back of curb and gutter or single curb. Single curb or curb and gutter located at the edge of roadway shall be paid for separately. The surface area of curb ramps shall not be included in the measured quantity for sidewalks.

340.6 PAYMENT:

Payment ~~for the above named items~~ will be made in accordance with the unit prices or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, material, tools and equipment and accomplishing all work in conformance with the contract documents.

Payment for curb ramps shall include the ramp curb and the walking surfaces between the ramp curb and back of curb and gutter or single curb.

Over-excavation of soft, expansive or unsuitable materials and installation granular materials will be paid as a separate pay item, not included with the above measured pay items.

SECTION 340

CONCRETE CURB, GUTTER, SIDEWALK, SIDEWALK RAMPS, DRIVEWAY AND ALLEY ENTRANCE

340.1 DESCRIPTION:

The various types of concrete curb, gutter, sidewalk, sidewalk ramps, driveways, and alley entrances shall be constructed to the dimensions indicated on the plans and standard detail drawings.

340.2 MATERIALS:

Concrete shall be as noted on the standard details. Concrete shall conform to the requirements of Section 725.

Expansion joint filler shall be ½-inch thick preformed bituminous material in compliance with Section 729, unless otherwise noted.

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

340.2.1.1 Color and Contrast: Detectable warnings shall contrast visually with adjoining surfaces, either light-on-dark or dark-on-light. Specific colors to be used shall be approved by the local jurisdictional agency prior to installation. Detectable warnings shall have integral color throughout.

340.2.1.2 Materials: Detectable warning materials shall be durable with a non-slip surface not subject to spalling, chipping, delamination, or separation. All detectable warnings shall be approved by the local jurisdictional agency prior to installation.

340.2.1.3 Attachment System: Detectable warnings shall be either placed in freshly poured concrete (wet-set) or recessed into pre-formed concrete. Detectable warnings using wet-set placement shall have an anchoring method that assures constant contact of the detectable warning bottom surface with the concrete as it cures, thus rendering the ramp a single monolithic structure. The thicker and heavier detectable warnings lowered into pre-formed recesses in the concrete substrate must demonstrate a firm fitting into metal reinforced frames without gaps along the edges that can channel water, sand, or debris. They must also be able to resist movement (i.e. sliding, rocking, or lifting) once in service. All attachment systems shall be approved by the local jurisdictional agency.

340.3 CONSTRUCTION METHODS:

Existing pavements and concrete that are joined by new construction shall be cut in accordance with Section 336.2.2.

340.3.1 Subgrade Preparation: The subgrade shall be constructed and compacted true to grades and lines shown on the plans and as specified in Section 301. All soft or unsuitable material shall be removed to a depth of not less than 6 inches below subgrade elevation and replaced with material satisfactory to the Engineer. Removal and replacement of soft or unsuitable materials will be paid for as extra work.

When the Engineer determines that the existing subgrade consists of soils with questionable swelling characteristics subgrade shall be tested in accordance with Table 340-1. The upper 6 inches of marginally expansive soils shall be compacted per Section 301.3 at a moisture content between 0% to 3% above optimum moisture per ASTM D698. Expansive soils shall be considered unsuitable and removed and replaced in accordance with the preceding paragraph. Alternate corrective measures may be submitted to the Agency by the Contractor or Permittee for review. The submittal must include recommendation affixed with the professional seal of an Arizona registered engineer

Table 340-1			
Description	Percent Fines (-#200 sieve) ⁽¹⁾	Plasticity Index ⁽²⁾	Liquid Limit ⁽³⁾
Non-expansive	> 20%	≤ 15	≤ 25
Marginally expansive		> 15 and ≤ 30	> 25 and ≤ 50
Expansive		> 30	> 50

(1) Tested in accordance with ASTM C117

(2) Tested in accordance with AASHTO T90 (wet prep per AASHTO T146)

(3) Tested in accordance with AASHTO T89 (wet prep per AASHTO T146)

Material removed for construction shall not be placed on the base and/or surfacing material already in place on the roadway nor shall the excavated material be placed in such a manner as to interfere with access to property or traffic flow in the street.

340.3.2 Formwork: Concrete curbs, gutters and sidewalks shall be constructed by the conventional use of forms, or may be constructed by means of an appropriate machine when approved by the Engineer.

If machines designed specifically for such work and approved by the Engineer are used, the results must be equal to or better than that produced by the use of forms. If the results are not satisfactory to the Engineer, the use of the machine shall be discontinued and the Contractor shall make necessary repairs at his own expense. All applicable requirements of construction by use of forms shall apply to the use of machines.

Forms conforming to the dimensions of the curb, gutter, sidewalk, sidewalk ramps, driveway, and alley entrance shall be carefully set to line and grade, and securely staked in position. The forms and subgrade shall be watered immediately in advance of placing concrete.

Forms shall be thoroughly cleaned each time they are used, and shall be coated with a light oil, or other releasing agent of a type which will not discolor the concrete.

340.3.3 Concrete Placement: The concrete shall be thoroughly spaded away from the forms so that there will be no rock pockets next to the forms. The concrete may be compacted by mechanical vibrators approved by the Engineer. Tamping or vibrating shall continue until the mortar flushes to the surface, and the coarse aggregate is below the concrete surface. The surface shall then be struck off and worked to grade and cross section with a float.

If machine placement is used, the machine shall place, consolidate and finish the concrete in one complete pass, requiring a minimum of hand finishing producing a dense and homogeneous section. A form shall trail behind the machine for such a distance that no appreciable concrete slumping will occur. Final finishing shall be as specified hereinafter.

340.3.4 Joints: Shall be constructed in a straight line, vertical plane and perpendicular to the longitudinal line of the sidewalk, curb and gutter, single curb, etc., except in cases of curved alignment, where they shall be constructed along the radial lines of the curve.

340.3.4.1 Expansion Joints: Shall be installed at all radius points, at both sides of each driveway, at both sides of each alley entrance, at every change of depth in the concrete and shall provide for complete separation of adjoining structures. The maximum distance between expansion joints shall be 50 feet.

Expansion joints shall be constructed to the full depth and width of the concrete and shall match joints in adjacent pavement, sidewalk, curb or gutter. The expansion joint material shall extend fully through the concrete and one inch into the subgrade with the top of the expansion joint material one-quarter inch below the top surface. Expansion joint material shall be secured in place prior to placement of concrete.

340.3.4.2 Contraction Joints: Unless otherwise specified, the large aggregate in contraction joints shall be separated to either side of the joint for a minimum depth equal to 25% of the concrete thickness; the finished depth shall be a minimum of ¾ inch..

Contraction joints in curbs and gutters shall match contraction joints in adjacent **attached** sidewalks.

340.3.5 Edges: All exposed edges shall be shaped with a suitable tool so form edges having the shape as indicated on the referenced detail.

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

Detectable warnings installed on sidewalk ramps shall modify the sidewalk concrete thickness at the detectable warning to provide a minimum concrete thickness of four-inches (4"). When detectable warnings are modules inset into the sidewalk ramp, the bottom surface of the sidewalk shall be lowered a distance equal to or greater than the module thickness to maintain the minimum sidewalk thickness. The sidewalk bottom surface shall have a minimum transition taper length of 12" between the thickened and normal depth sections of sidewalk. The detectable warning surface shall be located so that the edge nearest the curb line is 6 inches minimum and 8 inches maximum back from the face of curb.

Detectable warning surfaces for pedestrian at-grade rail crossings not located within a street or highway shall be installed on each side of the rail crossing, located as shown on plans. Detectable warnings shall extend the full width of the pedestrian walkway.

340.3.7 Form Removal and Finishing: The front face form shall not be removed before the concrete has taken initial set and has sufficient strength to carry its own weight. Gutter forms and rear forms shall not

be removed until concrete has hardened sufficiently to prevent damage to the edges. Any portion of concrete damaged while stripping forms shall be repaired or replaced at no additional cost to the Contracting Agency.

After the forms are removed, the joints shall be tooled and the surface finished with a float to remove all imperfections. **As needed, retool joints after finishing to prevent groove bonding.** In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The concrete work shall have a true surface; shall be free from sags, twists, or warps; have a uniform appearance; and be true to the lines, grades, and configurations indicated on the drawings.

Surfaces shall be light broom finished.

The Contractor shall stamp the company name and year on each end of the sidewalk or sidewalk ramp constructed. The letters shall not be less than 3/4 inch in height.

340.3.8 Curing: As soon after the completion of the finishing operations as the condition of the concrete will permit, all exposed surface shall either be sprayed with a pigmented curing compound or sealed with a material conforming to Section 726. Curing compound shall be applied under pressure through a spray nozzle in such manner and quantity as to entirely seal all exposed concrete surfaces with a uniform film. The membrane shall be applied in two applications for a total coverage of 150 square feet per gallon. Concrete surfaces shall be kept damp until the curing compound is applied. Should the curing compound seal be broken or damaged before the expiration of 10 days after the placing of the concrete, the break shall be immediately repaired by the application of additional curing compound over the damaged area. If due to weather conditions, materials used, or for any other reason, there is any likelihood of the fresh concrete checking or cracking before the curing operations, it shall be kept damp (not wet) by indirect fine spray of water until such danger is past, or until curing operations are started in the particular area affected. The need for adequate continuous curing is greatest during the first few hours after placement of concrete.

340.3.9 Tolerances: The face, top, back, and flow line of the curb and gutter shall not deviate in excess of 1/4-inch over 10 feet, as tested with a 10-foot straightedge or curve template, longitudinally along the surface.

The surface of concrete sidewalk or sidewalk ramp **in all directions** shall not deviate in excess of 1/8-inch over 5 feet as tested with a 5-foot straightedge except for the 1/4-inch recess of the preformed material in expansion joints.

All finished concrete elevations shall not deviate from the elevations shown on the plans, or indicated by typical sections or standard details referenced within the construction documents, by more than 1/2 inch.

When required by the Engineer, gutters shall be water tested. The Contractor shall establish flow in the length of gutter to be tested by supplying and distributing water from a hydrant, tank truck or other source. After the supply of water is shut off and water has stopped flowing, the gutter shall be inspected for evidence of ponding or improper shape. The work shall be deemed deficient if water is found ponded in the gutter to a depth greater than 1/2 inch or ponding extends onto the adjacent asphalt pavement.

Areas between elevations shown on the plans shall be straight graded or smoothly transitioned through a vertical curve in a manner approved by the Engineer or as otherwise indicated on the construction documents.

340.3.10 Deficiencies: Any section of the work deficient in depth or not conforming to the plans or specifications shall be removed and replaced by the Contractor at no additional cost to the Contracting Agency. Replacement or reconstruction shall be from joint to joint.

Concrete work that deviates in straightness as specified in Section 340.3.9 shall be removed and replaced.

Remove and replace gutters that exceed the ponding tolerance in Section 340.3. Grinding shall only be allowed if approved by the Engineer.

Remove and replace all work that exceeds the elevation tolerance in Section 340.3.

340.4 BACKFILLING:

Unless otherwise specified the Contractor shall backfill behind the curbs, sidewalk or sidewalk ramps with soil native to the area to the lines and grades shown on the plans.

340.5 MEASUREMENT:

Concrete curbs and gutters of the various types shown on the plans and in the proposal, will be measured along gutter flow line through inlets, catch basins, driveways, sidewalk ramps, etc., by the lineal foot to the nearest foot for each type, complete in place. Measurement for curb terminations and transitions shall be included with the linear measurement of the various types of curb or curb and gutter as shown on the plans and in the proposal.

Curb and gutter type shall be based on the configuration of the final exposed surfaces. The increased curb and gutter depth required at valley gutter aprons or driveways shall not be measured as a separate pay item; any additional Contractor cost shall be included in the unit cost associated with the valley gutter, driveway or other associated item.

Concrete sidewalks, driveways, alley intersections, valley gutters and aprons will be measured to the nearest square foot complete in place.

Detectable warnings shall not be measured for payment. Detectable warnings are considered integral to the walking surface that they form a part of and the cost is included in the related pay item.

Curb ramp installations shall be measured as complete installed units and shall include the ramp curb and the walking surfaces between the ramp curb and back of curb and gutter or single curb. Single curb or curb and gutter located at the edge of roadway shall be paid for separately. The surface area of curb ramps shall not be included in the measured quantity for sidewalks.

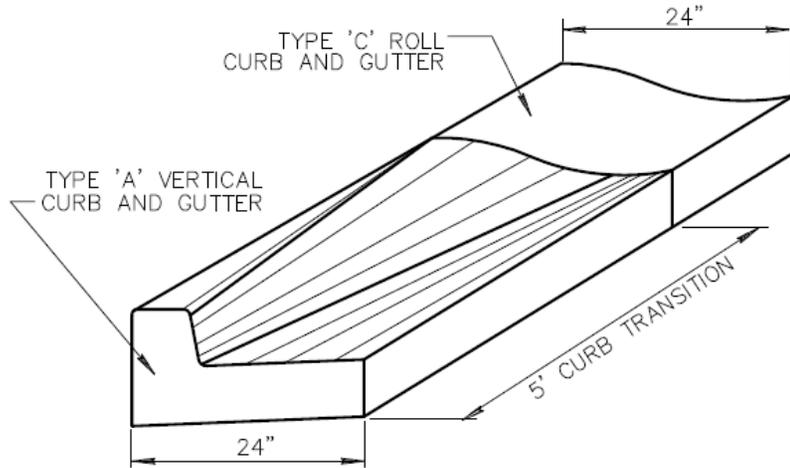
340.6 PAYMENT:

Payment will be made in accordance with the unit prices or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, material, tools and equipment and accomplishing all work in conformance with the contract documents.

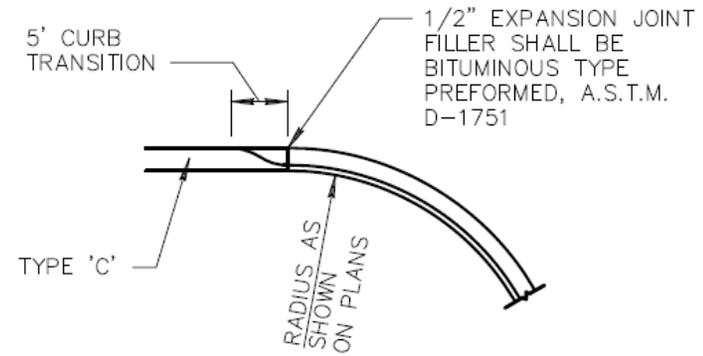
Payment for curb ramps shall include the ramp curb and the walking surfaces between the ramp curb and back of curb and gutter or single curb.

Over-excavation of soft, expansive or unsuitable materials and installation granular materials will be paid as a separate pay item, not included with the above measured pay items.

CURB TRANSITION TYPE 'A' TO TYPE 'C'



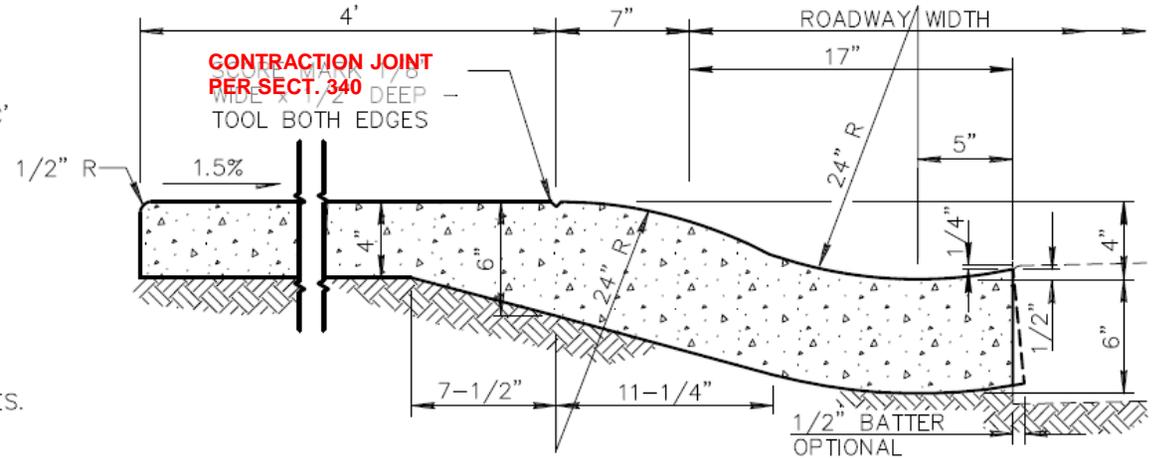
CURB AND GUTTER TRANSITION



NOTES: (CURB AND GUTTER TRANSITIONS)

1. TRANSITIONS WILL BE PAID FOR AS THE PREDOMINANT TYPE OF CURB AND GUTTER BEING TRANSITIONED. WHEN TYPE 'A' CURB AND GUTTER ARE USED AT CURB RETURNS AND TYPE 'C' CURB AND GUTTER IS PREDOMINANTLY USED ELSEWHERE, THE TYPE 'A' TO TYPE 'C' TRANSITIONS SHALL BE MEASURED AND PAID FOR AS TYPE 'C' CURB AND GUTTER.
2. WHERE PROPOSED CONSTRUCTION IS TO BE CONNECTED TO EXISTING CURB AND GUTTER, THE TRANSITION SHALL BE INDICATED ON PLANS.
3. CLASS 'B' CONCRETE PER SECT. 725.
4. TRANSITION BETWEEN TYPICAL SECTIONS SHALL BE ACCOMPLISHED BY THE USE OF DIRECT STRAIGHT LINE TRANSITIONS OF THE FLOW LINE AND OTHER SURFACE FEATURES.

INTEGRAL ROLL CURB, GUTTER AND SIDEWALK



NOTES: (INTEGRAL ROLL CURB, GUTTER AND SIDEWALK)

1. CONCRETE TO BE MONOLITHIC POUR. EXPOSED SURFACE FINISH AS PER SIDEWALK AND GUTTER DETAIL.
2. CONTRACTION JOINT SPACING 5' MAXIMUM.
3. EXPANSION JOINTS PER SECT. 340.
4. CLASS 'B' CONCRETE PER SECT. 725.

DETAIL NO.

221



STANDARD DETAIL
ENGLISH

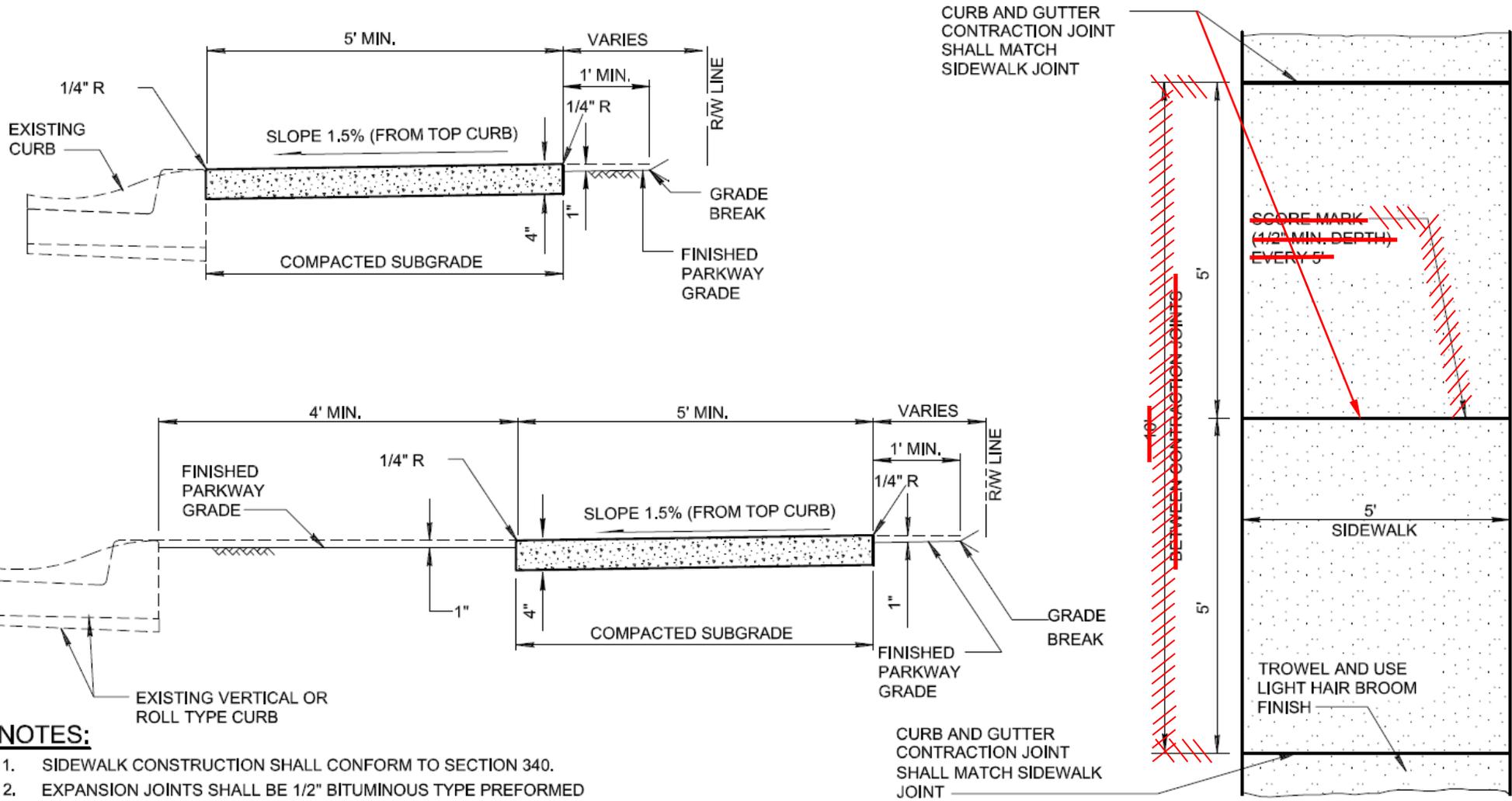
**CURB AND GUTTER TRANSITION TYPE A TO TYPE C
INTEGRAL ROLL CURB, GUTTER AND SIDEWALK**

REVISED

01-01-2011

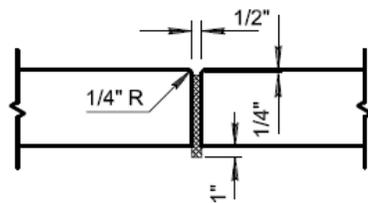
DETAIL NO.

221

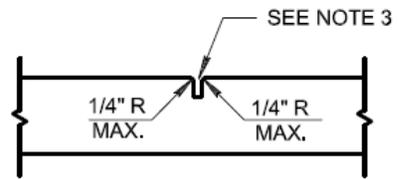


NOTES:

1. SIDEWALK CONSTRUCTION SHALL CONFORM TO SECTION 340.
2. EXPANSION JOINTS SHALL BE 1/2" BITUMINOUS TYPE PREFORMED EXPANSION JOINT FILLER, A.S.T.M. D-1751.
3. LARGE AGGREGATE, IN CONTRACTION JOINT SHALL BE SEPARATED TO A DEPTH OF 1", FINISH DEPTH SHALL BE A MINIMUM OF 3/4".
4. EXPANSION JOINTS SHALL CONFORM TO SECTION 340, BE INSTALLED PRIOR TO CONCRETE PLACEMENT, AND AT A MAXIMUM SPACING OF 50', THE EXPANSION JOINT MUST PROVIDE COMPLETE SEPERATION OF THE SIDEWALK FROM ADJOINING CONCRETE.
5. CONCRETE SHALL BE CLASS 'B' PER SECTION 725.
6. WHEN SIDEWALK AND ADJACENT CURB ARE INSTALLED MONOLITHICALLY, THE MID-POINT SCORE LINE SHALL EXTEND ACROSS THE CURB.



EXPANSION JOINT



CONTRACTION JOINT

DETAIL NO.
230



STANDARD DETAIL
ENGLISH

SIDEWALKS

REVISED
01-01-2011

DETAIL NO.
230

Relationship of Map Unit Variability to Shrink–Swell Indicators

P.J. Thomas, J.C. Baker, L.W. Zelazny and D.R. Hatch

A study was conducted in the Culpeper Basin in northern Virginia to quantify soil shrink–swell indicators, to relate the indicators to soil properties, and to partition variability into map unit components.

UNIFIED SOIL CLASSIFICATION CHART: RELATIONSHIP BETWEEN SWELL INDEX AND ATTERBERG LIMITS

The following discussion pertains to the variability study conducted on five map units in Fauquier County. Map units are Davidson, Haymarket, Jackland, Waxpool, and Kelly. See Chapter V for explanation of study design.

RESULTS AND DISCUSSION

Plasticity index, although highly correlated with liquid limit, did not correlate with swell index. However, when plotting swell index in against liquid limit and plasticity index on the Unified Classification System plasticity chart, a trend is observed (Figure B.1). Most soils with high and very high swell indices have high liquid limit and high PI. The line labeled “A” above a liquid limit of 50 separates soils of high plasticity, or fat clays (above line), from elastic clays, soils of low compressibility (below line). At liquid limits less than 50, line “A” separates soils of medium plasticity (above line) from soils of medium compressibility (below “A” line). Using this graph, critical lower limits of liquid limit and plasticity index can be ascertained. Soils that have high or very high shrink-swell potential would have liquid limits greater than 50 and plasticity indices greater than 30. Soils with moderate shrink-swell potential have liquid limits ranging from 25 to 50 and plasticity indices between 15 and 30. Low shrink-swell potentials are indicated by liquid limits less than 25 and plasticity indices less than 15.

SUMMARY

- Plotting liquid limit and plasticity index against swell index on the Unified Soil Classification System plasticity chart, a trend is observed. Almost all soils with high and very high shrink-swell potential have high liquid limit and plasticity index.
- In assessing risk for the map units using liquid limit and plasticity index as expansive soils predictors, low risk soils will have liquid limits less than 25 and PI less than 15. Moderate risk is indicated by liquid limit ranging from 25 to 50 and PI ranging from 15 to 30. High risk can be assumed if liquid limit is greater than 50 and PI is greater than 30.

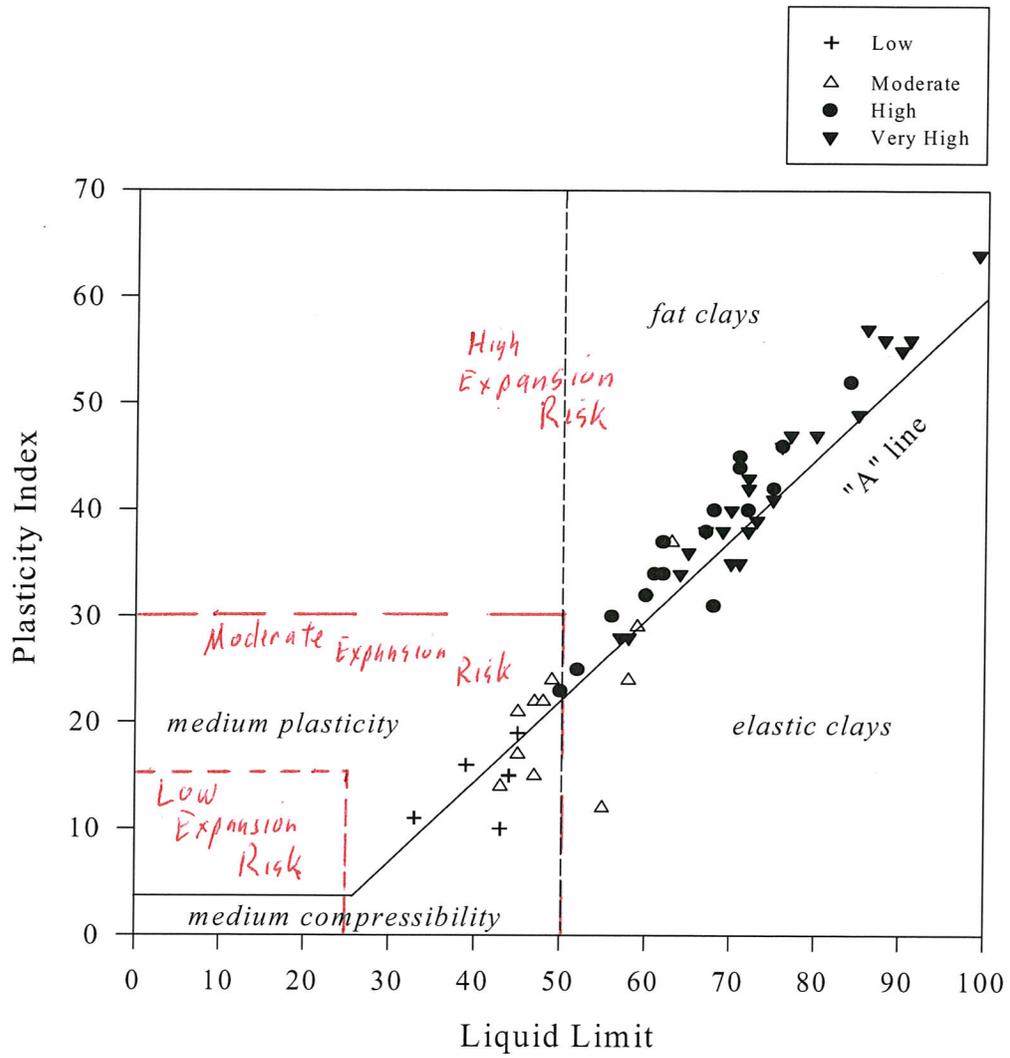


Figure B.1. Swell index as related to liquid limit and plasticity index.

The designer can conceive various alternative combinations of layers and thicknesses that will achieve the required design structural number (SN). Several different combinations are to be developed. The final design recommendation will be made after these alternative combinations are evaluated based on: 1.) Layered design analysis, 2.) Evaluation of the swell potential of the subgrade, and 3.) Construction cost analysis for the pavement.

10.2.4.3 Layered Design Analysis

The pavement structure is a layered system and each underlying layer affects the layers above it. The design equation presented above can be used to evaluate the adequacy of each layer to support the layers above it. The minimum SN for the pavement structure above a particular layer may be computed using the AASHTO formula and the resilient modulus (M_R) for that layer. The AASHTO guide (page II-36) should be referred to for a more complete explanation of the layered analysis approach.

A layered design analysis does not change the design structural number, but affects limits on some of the layer thicknesses. The most common impact on pavement designs is that it requires thicker layers of asphalt concrete on roadways with high traffic volume. A layered design analysis is required for Maricopa County Department of Transportation pavement designs.

10.2.4.3.1 Construction Constraints for Layer Thickness

The design thickness of asphalt concrete shall be rounded upward to the nearest ½-inch increment. The design thickness of granular base shall be rounded to the nearest 1-inch using a minimum layer thickness of 4-inches. The designed thickness of stabilized native or base shall be rounded to the nearest 1-inch with a minimum layer thickness of 6-inches.

10.2.4.4 Expansive and Collapsible Soils

Expansive soils in the roadway subgrade are detrimental to pavement performance in several ways. The resilient modulus of expansive soils is generally very low, expansion of the subgrade can reduce the ride quality and decrease the pavement's serviceability ratings, and differential movements can crack the pavement and propagate local failures causing increased maintenance costs. The pavement design process will incorporate the following measures in consideration of these detrimental effects.

Subgrade soils having a plasticity index above 15 with more than 20% passing the #200 sieve shall be considered potentially expansive. The engineer shall take additional samples or test existing samples as necessary to ensure that a minimum of 3 samples of any potentially expansive soil are tested. The treatment described in Table 10.2.8 will then be required based on the average of the three samples with the highest expansion potential. If it is not possible to obtain 3 samples representing a given expansive soil, the treatment given in Table 10.2.8 will be based on the test result of the sample with the highest expansion potential.

This method for treatment of swelling soils is a modification of a method presented in section 314 of the Airport Pavement Design and Evaluation Manual published by the Federal Aviation

Table 1. Soil expansivity prediction by liquid limit

Degree of expansion	w_L : % <i>Liquid Limit</i>	
	Chen ⁶	IS 1498 ⁴
Low	<30	20-35
Medium	30-40	35-50
High	40-60	50-70
Very high	>60	70-90

Table 2. Soil expansivity predicted by plasticity index

Degree of expansion	I_p : % <i>Plastic Index</i>		
	Holtz and Gibbs ¹⁰	Chen ⁶	IS 1498 ⁴
Low	<20	0-15	<12
Medium	12-34	10-35	12-23
High	23-45	20-55	23-32
Very high	>32	>35	>32

(Table 3), free swell index (FSI) (Table 3), activity and per cent free swell.^{4,9-14}

7. Chen⁶ observed that there was no conclusive evidence of the correlation between swelling potential and shrinkage limit. Sridharan and Prakash¹⁵ have also shown that the shrinkage limit can not be satisfactorily used to predict the swell potential of a soil and that the mechanisms governing the shrinkage and swelling are entirely different.

8. Holtz and Gibbs¹⁰ proposed the per cent free swell test. It consists of pouring slowly 10 cm³ of oven dried soil (passing a 425 μm sieve) into a 100 cm³ measuring jar filled with distilled water and noting the volume of the soil after it comes to rest at the bottom of the jar. The free swell is then reported as the increase in the volume of the soil expressed as a percentage of the initial volume. The major drawback of this method, which is crude,⁶ is that measuring 10 cm³ of soil is not that easy and the procedure therefore introduces personal judgement as one more factor. It is normal to quantify 10 cm³ as the volume occupied by 10 g of

soil. This does not account for variations of density.

9. IS 1498⁴ gives a criterion to predict the expansivity of soils, based on the free swell index.¹⁶

$$FSI = \frac{(V_d - V_k)}{V_k} \times 100 \quad (1)$$

where V_d is the sediment volume of 10 g of oven dried soil passing a 425 μm sieve placed in a 100 ml graduated measuring jar containing distilled water, and V_k is the sediment volume of 10 g of oven dried soil passing a 425 μm sieve placed in a 100 ml graduated measuring jar containing kerosene.

10. However, this method gives negative free swell indices for kaolinite-rich soils and may underestimate the expansivity of montmorillonitic soils, if the soils contain a significant amount of kaolinite clay material. To eliminate this difficulty, Sridharan *et al.*¹⁷ have defined the modified free swell index (MFSI) as the ratio of equilibrium sediment volume (V_d) after 10 g of oven dried soil is mixed thoroughly with the distilled water to form a soil-water suspension of 100 ml initial volume in a 100 ml measuring jar and allowed to settle, to the dry weight of the soil. Thus

$$MFSI = \frac{V_d}{10} \quad (2)$$

11. Sridharan *et al.*¹⁸ have observed that the sediment volume occupied by unit weight of dry soil in distilled water together with that in carbon tetrachloride provides useful information about the soil expansivity and nature of the soil type—expansive/non-expansive/combination of both (Table 4).

12. The predictive capability of the MFSI is evident from the following statistical illustrations. About 32 soils from various parts of India, 16 of them kaolinitic ($25\% \leq w_L \leq 100\%$) and the remaining 16 montmorillonitic ($47\% \leq w_L \leq 124\%$), were considered for the analysis (data from Sridharan *et al.*^{19,20}). These soils are placed on the plasticity chart as shown in Fig. 1. It can be noted that both the kaolinitic

Table 3. Soil expansivity predicted by other measures

Degree of expansion	Colloid content ¹⁰ : % minus 0.001 mm	Shrinkage limit ¹⁰ : %	Shrinkage index ⁴ : %	Free swell index ⁴ : %	Per cent expansion in oedometer* as per Holtz and Gibbs ¹⁰	Per cent expansion in oedometer† as per Seed <i>et al.</i> ¹²
Low	<17	>13	<15	<50	<10	0-1.5
Medium	12-27	8-18	15-30	50-100	10-20	1.5-5.0
High	18-37	6-12	30-60	100-200	20-30	5-25
Very high	>27	<10	>60	>200	>30	>25

* From dry to saturated condition under a surcharge of 7 kPa.

† From compacted, saturated condition under a surcharge of 7 kPa.

Note: Shrinkage index = (plastic limit - shrinkage limit).