CHAPTER 7

PAVEMENT DESIGN

7.0 GENERAL

The purpose of this chapter is to define the requirements for design of pavement within proposed and existing roadways for new subdivision streets and secondary roads.
Pavement design for higher classifications will conform to AASHTO Pavement Design and VDOT Guidelines for AASHTO Pavement Designs.
Pavement design submittals must contain all applicable supporting information, calculations, geotechnical reports and supporting reference materials.

7.1 SOIL ANALYSIS

The following information shall be submitted to the Department of Development & Permits with the pavement design:

A. 10' boring logs of sufficient quantity to determine the soil profile, related to elevations are required. These borings shall reflect the ground water elevations, description of materials and blow counts on the sampler. Borings shall reflect normal water table elevation, and projected seasonably high water table elevation. Maximum spacing of borings to be 500 feet, and located in the proposed streets. No less than two borings are required with any pavement design. All soil tests are to be performed by a professional engineer licensed to perform this type of work. A maximum average CBR of 4 may be assumed for preliminary design. However, all borings must be submitted prior to plan approval and a revised design approved if an assumed CBR was used in the initial design. Hand auger borings are not acceptable.

B. Soil analysis of subgrade material shall include:

1. Gradation (sieve and hydrometer analysis)
2. Atterberg limits
3. Moisture density relationships and curves
4. Maximum dry weight
5. Optimum moisture content
6. Specific gravity
7. Swell
8. California Bearing Ratio in accordance with the Virginia Test Method (VTM-8).

a. Soaked and unsoaked test results required.

b. Tests are to be taken at the proposed street subgrade elevation.

c. Maximum spacing of test shall be 500 feet (250' radius of coverage per test). No less than 2 tests are to be provided.

7.2. PAVEMENT DESIGN

A. Alleys and service roads serving residential developments - The pavement shall be in accordance with one of the following alternates:

1. The pavement shall be a 6" thickness of Class A-3 (Virginia Department of Transportation Specifications) concrete placed on a compacted subgrade with a minimum soaked CBR of 10.

2. The pavement shall be a Class A-3 (Virginia Department of Transportation Specifications) concrete, thickness designed for unlimited stress repetitions of a single axle load of 20,000 pounds, in accordance with "Thickness Design for Concrete Pavements" (HB-35 published by the Portland Cement Association.)

B. The design method for public streets shall be as follows:

1. Rigid Pavement Design

Rigid Pavement Design shall be in accordance with the publication "Thickness Design for Concrete Pavement" (HB-35 published by Portland Cement Association). The traffic volume and characteristics shall be calculated as specified in this criteria.

2. Flexible Pavement Design

Flexible Pavement Design shall be in accordance with the method in the publication VDOT Pavement Design Guide for Subdivision and Secondary Roads including all current addenda. (See Appendix 5 and available online at http://virginiadot.org/business/manuals-default.asp). The "Vaswani" Method shall be adjusted to reflect the percent heavy trucks when used to design 'higher type' street pavements.

3. AASHTO Pavement Design

When the projected Average Daily Traffic exceeds 10,000 trips, AASHTO Pavement Design method should be employed.

C. The use of a design which utilizes soil cement must include the following test:

1. Methods of Test for Moisture Density Relations of Soil-Cement Mixtures, ASTM Designation: D558; AASHO Designation: T134.

2. Methods of Wetting and Drying Test of Compacted Soil-Cement Mixtures, ASTM Designation: D559; AASHO Designation T135.

3. Methods of Freezing and Thawing Test of Compacted Soil - Cement Mixtures ASTM Designation: 560; AASHO Designation: T136. Soil-Cement loses during 12 cycles of either the wet-dry test or freeze-thaw test shall conform to the following limits:

Soil Groups A-1, A-2-4, A-2-5, and A-3 not over 14 percent

Soil Groups A-2-6, A-2-7, A-4 and A-5, not over 10 percent

Soil Groups A-6 and A-7, not over 7 percent

Compressive strengths should increase both with age and with increases in cement content within the ranges of cement content producing results that meet requirements of the freezer-thaw and the wet-dry test.

The above tests are detailed in PCA Soil-Cement Laboratory Handbook. Short-cut Test Procedure outlined in the PCA Soil- Cement Laboratory Handbook dated 1971 can be used only with soils containing less than 50% material smaller than 0.05mm (silt and clay) less than 20% material smaller than 0.005mm (clay) and less than 45% material retained on the No. 4 sieve dark gray to black soils with appreciable amounts of organic impurities cannot be used. Also, granular soils containing material retained on the No. 4 sieve that has a bulk specific gravity less than 2.45 cannot be used.

D. Regardless of street or pavement section proposed no portion of the pavement section shall be placed within 6" of the seasonably high water table. Seasonal water table shall be projected based on water table observation at time of test and adjusted for the time of year, soil gradation and topography (extreme weather conditions must be considered). Deviation from 6" min. may be accommodated by using alternative designs found in "Drainage Considerations for Flexible and Rigid Pavements" in PFM Appendix 5, and VDOT Pavement Design Guide.

E. The pavement design for individual streets within a development should be based on the soil analysis that best represent the soil conditions for that street. In a development with homogeneous soils, an overall average CBR will be acceptable.

F. CL and CH subgrade materials are unacceptable in the pavement structure. If this soil is found in the soil borings, the soil must be undercut and backfilled with select material.

G. Minimum flexible pavement section for public streets that do not exceed 350 vpd:

1.5 inch bituminous concrete surface course Tack coat.
3 inch bituminous base course.
6 inch aggregate sub-base course.
6 inch compacted subgrade.

H. Streets exceeding 350 VPD must provide separate pavement design. This design accommodates typical construction sequence application of final surface following majority of construction traffic use. Adequate cross slopes/weep holes shall be provided to prevent pudding at the catch basins while the surface course is not in place.

I. No credit will be given for select material placed over subgrades where the average of the CBR test results used in the design is greater than 15.

J. Not less than 33% of the required flexible pavement structure strength shall be composed of bituminous materials.

K. Aggregate base materials, including crushed hydraulic cement concrete, shall meet requirements of VDOT's current Road and Bridge Specifications.

Type I- Aggregate base material (crushed material only)
Aggregate Number 21A or 21B (for < 1000 projected ADT).
Aggregate Number 21B (for > 1000 projected ADT).
Type II- Aggregate base material (crushed or uncrushed material)
Aggregate Number 21A or 22 (use for ADT of 1000 or less).

Type I materials are normally crushed, quarry materials. Type II materials are normally processed, locally available materials.

If crushed concrete aggregate base material is proposed, a plan revision may be submitted for evaluation. Plan submittal must include two (2) gradation analysis meeting VDOT specification Section 208. Laboratory analysis of samples shall be performed within 3 months from date of placement of material and shall be performed by a 3rd party testing laboratory. A Soundness test and Abrasion Loss in accordance with VDOT Section 208.03 may be required.

J. The pavement section shall specify the tack coat on the construction plans. If total asphalt thickness is equal to or exceeds four (4) inches, a prime coat may not be required. A tack coat will be used over base course and intermediate course if the subsequent course is not placed the same day and/or if traffic has been driving on the surface. See VDOT Road and Bridge Specifications.

K. The pavement section for additional traffic lanes shall be based on traffic counts but under no circumstances shall it be less than the existing adjacent pavement section.

L. A full depth asphalt section may be used on the following streets in lieu of matching the existing concrete section with an asphalt overlay.

1. Military Hwy.

2. Western Branch Blvd.

3. North Battlefield Blvd.

4. Airline Blvd.

M. Lane additions and pavement cuts shall have the same surface material as the existing adjacent pavement.

7.3 TRAFFIC VOLUMES

A. Existing Streets

Actual traffic counts and 20-year projected traffic volumes shall be used as a basis for calculating the design traffic volume. This 20-year traffic projection shall be provided by Public Works. The design traffic volume shall be determined by means of the existing traffic volume and the 20 year projected volume. The growth rate shall be 5% per year. Alternative growth rates may be used based on previous approved studies.

B. Proposed Streets

The following minimum 24 hour trip generation information shall be used to determine traffic volumes for undeveloped areas:

NOTE: It is the engineer's responsibility to verify current density/zoning relationships.

For land uses other than residential, the trip generation should be calculated using the latest edition of ITE "Trip Generation".

A-1 [1 dwelling unit per parcel] -- 10 trips per day per parcel rate--10 trips per day per dwelling unit [no major subdivisions permitted, must have residential classification].

RE-1 [.33 dwelling units per acre] -- 3 trips per day per acre rate-- 10 trips per day per dwelling unit.

R-15 [2.3 dwelling units per acre] -- 23 trips per day per acre rate-- 10 trips per day per dwelling unit.

R-10 [3.5 dwelling units per acre] -- 35 trips per day per acre rate-- 10 trips per day per dwelling unit.

R-12 [2.9 dwelling units per acre] -- 29 trips per day per acre rate-- 10 trips per day per dwelling unit.

R-MF-1 [15 dwelling units per acre] -- 91 trips per day per acre rate--6.1 trips per day per dwelling unit.

R-TH-1 [10 dwelling units per acre} -- 61 trips per day per acre rate-- 6.1 trips per day per dwelling unit.

B-1 & B-2 [Building area per acre -- 19602 sq. ft.]

* Equation -- ln (T) = 0.65 ln (19.602 x) + 5.92

B-3 [Building area per acre -- 21780 sq. ft.]

* Equation -- ln (T) = 0.65 ln (21.780 x) + 5.92

B-4 [Building area per acre -- 15246 sq. ft.]

* Equation -- ln (T) = 0.65 ln (15.246 x) + 5.92

O-I [Building area per acre -- 19602 sq. ft.]

* Equation -- ln (T) = 0.92 ln (19.602 x) + 2.9

M-1 [Building area per acre -- 21780 sq. ft.]

* Equation -- ln (T) = 0.79 ln (21.780 x) + 2.87

M-2 [Building area per acre -- 21780 sq. ft.]

* Equation -- T = 3.88 (21.780 x) - 13.0

* Where (T) equals trips per day and (x) equals number of acres.

- Equations from Trip Generation Manual (4th edition) Institute of Transportation Engineers.
- Figures must be adjusted when more detailed information is available.

C. Through Streets

When proposed streets intersect the property line of the development and provide access with adjoining undeveloped property, the design traffic shall be based on:

a. Number of acres expected to contribute traffic to this street.

b. Ultimate development of property based on the LAND USE PLAN, developed by the Planning Department.

c. Total number of units expected to contribute to subject street.

d. A detailed topo or other map shall be submitted showing the offsite area and ultimate zoning. All assumptions of future traffic flow must be included. Future Zoning shall be derived from the approved LAND USE PLAN.

e. Master Transportation Plan roadways must include a projected through volume.