CHAPTER 8 – PAVEMENT DESIGN

Chapter Organization

List of Tables

8.1 INTRODUCTION

This chapter provides the minimum requirement for the design of pavement sections for streets within the City. The use of these design criteria will ensure that paved transportation corridors are improved in a uniform and consistent manner.

The requirements presented in this chapter have been established to minimize structural failures in streets, due to traffic loadings and/or existing soils conditions.

8.2 STREET CLASSIFICATION

All public streets in the City have been classified using the Federal Functional Classification system, which provides a hierarchy from principal arterials to local access streets, to accommodate existing and anticipated traffic. Street classifications can be found in the City of Spokane Valley's currently-adopted *Comprehensive Plan*.

A street's classification is used to determine the volume and mix of vehicles for which it is designed. In cases where a street has yet to be designated a specific classification, the anticipated traffic volume should be used.

If available, the City may provide the anticipated daily traffic for a street. However, the Applicant may be required to obtain additional traffic information.

8.3 STREET PAVEMENT AND SUBGRADE

8.3.1 RESIDENTIAL ZONES

The requirements of this section apply to local access streets, private streets, alleys, and private driveways located in residential zones.

For the purpose of pavement design, the engineering characteristics of the subgrade soil shall be determined through laboratory testing. Laboratory testing consisting of California Bearing Ratio (CBR) testing, Resilient Modulus (M_r) testing or Resistance Value (R-value) testing may be used to characterize the subgrade soil supporting capability.

A minimum street section of three inches of hot mix asphalt (HMA) over six inches of properly placed and compacted crushed rock is required for local access streets, private streets, and alleys regardless of native soils. A minimum pavement section of two inches of HMA over six inches of crushed rock is required for private driveways.

A soils investigation is required for all projects. The minimum pavement section cannot be used for sites with poor subgrade soils, which are soils that meet any of the criteria below:

a. Have CBR less than three;

b. Have R-values less than 20;

c. Have M_r values less than 3,000 psi; or,

d. Are classified as MH, CL, CH, OL or peat in accordance with the Unified Soil Classification System.

When results of laboratory testing indicate that poor subgrade soils are present, an engineered pavement design is required. Subsurface explorations (borings/test pits) are required for each street to demonstrate the subgrade soils meet the criteria above. Exploration should extend to a depth of at least five feet below proposed pavement subgrade.

8.3.2 NON-RESIDENTIAL ZONES

Engineered pavement design is required for commercial local access streets, commercial alleys, collector arterials, and arterials. The resilient modulus value can be acquired using the following methods:

a. M_r testing: Soil samples shall be obtained and sent to a private lab for testing. The proposed street shall have a minimum of one laboratory test for every 1,000 feet of street and/or for every obvious change in subgrade material (minimum of three tests per street).

b. CBR testing or R-value testing: Soil samples shall be obtained and sent to a private lab for testing. The proposed street shall have a minimum of one laboratory test for every 1,000 feet of street and/or for every obvious change in subgrade material (minimum of three tests per street). A geotechnical engineer shall be retained to provide recommendations for correlations between CBR or R-value results and M_r values.

c. In-situ testing using a non-destructive deflection test method: The Applicant shall obtain approval from the City for the type of non-destructive deflection test method proposed, before conducting the testing. For non-destructive deflection testing, a statistical analysis is needed. The results shall be reported by street stationing. Test results shall include a graph of the resilient modulus values vs. street stationing. The graph shall be included in the pavement design report.

A minimum street section of four inches of HMA over six inches of properly placed and compacted crushed rock is required regardless of the pavement design results in accordance with Section 8.4.

8.3.3 SUBGRADE PREPARATION

Prior to placing any street base material, the subgrade shall be rolled and compacted to a minimum of 95% of the maximum dry density as determined by ASTM D-1557 (Modified Proctor). This degree of compaction shall extend to a depth of at least one foot below pavement subgrade elevation in cut areas. The fill areas shall be compacted to at least 95% of the maximum dry density based on ASTM D1557 and WSDOT Standard Specification 2-03.3(14)C Compacting Earth Embankments, Method C. Fill placed more than two feet below pavement subgrade elevation shall be compacted to at least 95% of the maximum dry density based on ASTM D1557.

Any street section which cannot be compacted to the degree specified above shall be removed to a depth of two feet or to a depth where the pumping ceases, or as directed by the Onsite Inspector, and replaced with granular imported material that can be compacted to at least 95% of the maximum density as determined by ASTM D-1557, or as directed by the onsite Inspector.

Prior to placing any sub-base or base materials, geo-textile fabric on the subgrade may be required if the existing subgrade is a fine-grained soil (ML, CL, MH, or CH). The geotextile fabric shall meet the criteria in Section 9.33 for "Separation" of the most current version of the WSDOT *Standard Specifications*. If the material is unsuitable, the soil shall be excavated below grade and compacted per WSDOT *Standard Specification* 2-03.3(3) and 2-03.3(14) Method C.

8.4 ENGINEERED PAVEMENT PARAMETERS

Engineered pavement designs shall be pursuant to the most current version of the *AASHTO Guide for Design of Pavement Structures* for flexible pavements and the following criteria:

8.4.1 TRAFFIC PARAMETERS

The existing traffic levels shall be increased to match the projected traffic at the end of the street design life. The minimum design life shall be 20 years. The growth rate is 1.5% for residential streets and 3.5% for commercial/industrial streets and arterial streets. The 1.5% growth rate may be waived in closed subdivisions with City approval. This growth rate shall only be used for pavement design purposes and shall not be used for traffic analyses.

The engineer shall submit Equivalent Single-Axle Loads (ESALs) calculations. The truck factors found in Table 8.1 may be used in the absence of other information.

TABLE 8.1 – EQUIVALENT SINGLE AXLE LOADS

VEHICLE TYPE	TRUCK FACTOR (ESALs/VEHICLE)
School Bus	2.87
STA Bus	2.57
Refuse Truck	1.03
All other trucks (averaged)	0.42

8.4.2 RELIABILITY LEVEL

The reliability level (R) for residential streets and local non-residential streets is 75%. For all other street classifications, the reliability level is 90%.

8.4.3 OVERALL STANDARD DEVIATION

The overall standard deviation (S) is 0.45 for new construction and 0.49 for overlay projects.

8.4.4 INITIAL AND TERMINAL SERVICEABILITY INDEXES

The initial and terminal serviceability indexes shall be per Table 8.2.

TABLE 8.2 – INITIAL AND TERMINAL SERVICEABILITY INDEXES

STREET CLASSIFICATION	PSI(INITIAL)	PSI(TERMINAL)
Private streets, alleys, access street, residential streets & local non-residential	4.2	2.00
Collector and minor arterials	4.2	2.25
Principal arterials	4.2	2.50

8.4.5 STRUCTURAL LAYER COEFFICIENTS

Structural Layer Coefficients (aj) for new material shall be in accordance with Table 8.3.

TABLE 8.3 – STRUCTURAL LAYER COEFFICIENTS

MATERIAL	STRUCTURAL COEFFICIENT
HMA	0.42
Crushed rock	0.14
Gravel base	0.10

8.4.6 DRAINAGE LAYER COEFFICIENTS

Drainage coefficients (m_i) for crushed rock and gravel base shall be in accordance with Table 8.4. This coefficient is used to modify the structural layer coefficients of untreated base and sub-basin materials in flexible pavements. If limited information is available regarding drainage conditions, a value of 0.95 may be used.

TABLE 8.4 – RECOMMENDED DRAINAGE COEFFICIENTS

PERCENT OF TIME PAVEMENT STRUCTURE IS EXPOSED TO MOISTURE LEVELS APPROACHING SATURATION				
Quality of Drainage	Less Than 1%	1-5%	5-25%	Greater Than 25%
Excellent	1.40-1.35	1.35-1.30	1.30-1.20	1.20
Good	1.35-1.25	1.25-1.15	1.15-1.00	1.00
Fair	1.25-1.15	1.15-1.05	1.00-0.80	0.80
Poor	1.15-1.05	1.05-0.80	0.80-0.60	0.60
Very Poor	1.05-0.95	0.95-0.75	0.75-0.40	0.40

8.4.7 SUBGRADE EVALUATION

Prior to designing the pavement thickness, the subgrade soil shall be evaluated in accordance with Section 8.3.2 to establish a design M_r value. The following moduli ratios (ratio of seasonal moduli to "summer" module) found in Table 8.5 can be used to determine the effective roadbed (subgrade) resilient modulus value (M_{Reff}):

TABLE 8.5 – MODULI RATIO

SAMPLE COLLECTION PERIOD	MODULI RATIO
Winter (January)	1.00
Winter & Spring (February through May)	0.85
Summer (June through September)	1.00
Fall (October through December)	0.90

8.5 REPORT SUBMITTAL

The Applicant shall submit a geotechnical report for all sites. The report shall be prepared and stamped by an engineer with experience in geotechnical engineering. The report shall include, as applicable:

a. Narrative of the site conditions and soils;

b. Recommended pavement section;

c. Site plan showing soil sample locations;

d. Field data; including boring or test pit logs;

e. Laboratory testing results, including discussion of CBR/modulus subgrade correlation or R value/modulus subgrade correction; and,

f. Pavement design calculations.

8.6 MATERIALS SPECIFICATIONS

The following material requirements refer to or amend the most current version of the WSDOT *Standard Specifications*.

8.6.1 GRAVEL BASE

Gravel base shall be bank run gravel, defined as naturally occurring material having characteristics such that when compacted in place on the street, it provides a course having greater supporting value than the subgrade on which it is placed. It shall be pursuant to Section 9-03.10 of the most current version of the WSDOT *Standard Specifications*.

8.6.2 CRUSHED ROCK

Crushed rock used shall fall under the following two classifications:

a. Crushed Surfacing Top Course (CSTC)

b. Crushed Surfacing Base Course (CSBC)

CSTC and CSBC shall be in accordance with Section 9-03.9(3) of the most current version of the WSDOT *Standard Specifications*, including the following modification:

The crushed aggregate portion which is retained on the No. 4 sieve shall contain not more than 15%, by weight, of flat or elongated pieces as defined in ASTM D 693. The crushed aggregate shall have at least 90% by weight of particles with at least one fractured face. The area of each face shall be equal to at least 75% of the smallest mid-section area of the piece.

8.6.3 ASPHALT OR CONCRETE TREATED BASE

When compaction soils type or moisture content precludes proper compaction, asphalt treated base (ATB) or concrete treated base (CTB) should be utilized.

8.6.4 HOT MIX ASPHALT

Hot mix asphalt shall pursuant to the most current version of the WSDOT *Standard Specifications*. Pavement design calculations shall be performed by an Engineer experienced with performance grade oils and pavement design calculations. Asphalt used in City street construction shall use performance grade asphalt binders, pursuant to AASHTO Designation MP-1. The minimum base binder used shall be PG-64-28. Required base binders based on street type and condition are provided in Table 8.6.

TABLE 8.6 – PERFORMANCE GRADE

STREET CLASSIFICATION	PERFORMANCE GRADE
Local access, private streets, and alleys	64-28
Collectors and arterials	70-28

Aggregate for use in hot mix asphalt shall be Class 1/2–inch in accordance with Section 9-03.8(1) of the current version of the WSDOT *Standard Specifications*.

8.6.5 IN-PLACE MAINLINE ASPHALT COMPACTION TEST REQUIREMENTS

A lot consists of five random individual tests. Minimum density testing requirements are one lot per 400 tons of HMA or one lot per day, whichever results in the greater number of lots. A lot shall be rejected if any of the following occurs:

a. The average compaction of the lot is less than 92% of maximum density, as determined by WSDOT FOP for AASHTO T166 and T209; or;

b. Any individual compaction test in the lot is less than 91% or higher than 96% of the maximum density, as determined by WSDOT FOP for AASHTO T166 and T209.

Additional testing requirements shall be pursuant to Appendix 9-A.

8.6.6 COLD JOINT REQUIREMENTS

Section 5-04.3(10)B of the current version of the WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* is supplemented as follows:

a. Extreme care shall be exercised in the construction of cold joints to ensure that the joint is properly tacked with a uniform and heavy coating of an approved tacking agent, that the placement of HMA adjacent to the cold joint is properly raked and that the adjacent hot mix is rolled and compacted in such a manner so as to completely seal the joint. The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall be the same texture as other sections of the course and meet the requirements for smoothness and grade.

b. If in the opinion of the City, the cold joint has not been properly constructed, the joint shall be sealed with a joint compound sealant pursuant to AASHTO M 324, at the Contractor's expense.

8.6.7 LONGITUDINAL AND TRANSVERSE JOINT REQUIREMENTS

Section 5-04.3(12) Joints of the current version of the WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* is supplemented as follows:

a. The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall be the same texture as other sections of the course and meet the requirements for smoothness and grade.

b. When paving occurs on an arterial street, cold joints will be limited to the centerline of the roadway and shall be constructed pursuant to Standard Plan R-127-Step Wedge Longitudinal Cold Joint. A paving plan shall be submitted, to the City detailing how the work is to be accomplished. Where possible, the Contractor shall use multiple pavers in order to reduce or eliminate longitudinal joints.

8.6.8 TACK COATS – PREPARATION OF EXISTING SURFACES

Section 5-04.3(5)A, paragraph two of the current version of the WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* is hereby amended as follows:

a. A tack coat of asphalt shall be applied to all paved surfaces on which any course of HMA is to be placed or abutted. Tack coat shall be uniformly applied to cover the existing pavement with a thin film of residual asphalt, free of streaks and bare spots. The application rate shall be 0.02 to 0.08 gallons of retained asphalt per square yard. If the tack coat has been diluted with water, as allowed in this section, then the application rate must be adjusted in order to achieve the retained amount of asphalt required. A heavy application of tack coat will be applied to all joints. Thin lifts of pavement require heavier applications of tack coat to prevent raveling,

spalling and delamination. As a guide, existing surfaces that are coarse, dry or milled require a higher application rate of tack coat than surfaces that appear rich or bleeding. For streets open to traffic, the application of tack coat shall be limited to surfaces that will be paved during the same working shift. The spreading equipment shall be equipped with a thermometer to indicate the temperature of the tack coat material.

8.6.9 COVER ASPHALT LOADS DURING TRANSPORT

Tarpaulin material shall be used to cover asphalt loads during transport from plant to project for all projects when the ambient air temperature is 50°F or less.

8.6.10 BREAKDOWN ROLLING MAXIMUM TEMPERATURE LOSS

Breakdown rolling shall occur before 20°F or greater temperature loss of the mix from the point of laydown. Temperature for basis shall be that observed and recorded in the transport vehicle at time of discharge to the paver.

8.6.11 ASPHALT TEMPERATURE PLACEMENT REQUIREMENTS

Table 8.7 shows the minimum laydown temperatures and rolling times. Vibratory compaction shall not be used after the asphalt mat cools below 175°F. The rolling pattern shall be established in conjunction with asphalt density testing.

TABLE 8.7 RECOMMENDED MINIMUM LAYDOWN TEMPERATURE

	MAT THICKNESS (INCHES)					
Base Temp, F	½	¾	1	1 ½	2	>3
40-50			310	300	285	275
50-60		310	300	295	280	270
60-70	310	300	290	285	275	265
70-80	300	290	285	280	270	265
80-90	290	285	275	270	265	260
< 90	280	275	270	265	260	255
Rolling Time (min)	4	6	8	12	15	15

1. Reference is Table 6-4 from the National Center for Asphalt Technologies, Hot Mix Asphalt, Mixture Design and Construction.
2. Time available between recommended laydown temperature and cessation temperature (175°F) when attempts to compact the mat should cease.
3. These compaction temperatures are estimates and will vary with different asphalt cements and aggregates. For thin mats, the time available for rolling is short. For example, a ¾-inch mat placed at the recommended minimum laydown temperature has only six minutes to be compacted to achieve the target density. The roller speeds cannot be increased significantly without adversely affecting density; hence, additional rollers may be required when paving at low temperatures.
4. Subgrade cannot be frozen for laydown. Subgrade may be required to be protected depending on the outside temperatures. Compaction requirements shall be met.

8.6.12 PAVING DATES & WEATHER LIMITATIONS

WSDOT Section 5-04.3(16) Weather Limitations is amended as follows:

a. HMA shall not be placed on any traveled way between October 1st and April 1st without written approval from the City.

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