We follow the 1993 version of the AASHTO Pavement Design Guide as closely as possible.

CAVEATS:
a. The information on this document is not official Department policy but it represents good pavement design practice.
b. The information contained herein pertains only to flexible pavement designs. If concrete is being considered or if the project entails overlaying concrete pavement, the procedure varies significantly from the one presented below.

The pavement structural design is based on traffic repetitions (Equivalent Single Axle Loads, or ESALs) accumulated over the life of the pavement.

New Construction, Reconstruction

For new construction or reconstruction, only the design Structural Number (SN_f) is required.

Rehabilitation

For rehabilitation, two numbers are needed: the effective existing SN and the future SN (SN_f , just like for new construction or reconstruction).

Widening

For widening projects, the widened section needs only a design SN (SN_f), but the rest of the pavement structure should be done as a rehabilitation design.

Preservation

Preservation projects are not designed to add structure but to extend the life of the pavement. A structural design is not necessary – only an evaluation of condition showing that the pavement is structurally adequate.

Pavement Design Tools and Checklist

A. Getting the ESALs over the design period:

Use the Excel spreadsheet named ESALCALC.xls for the appropriate road functional class.
If you have more specific site information, you may change the classification percentages for each truck class. For instance, if the percent heavy trucks is very different from the defaults, simply adjust the percentages for the ESAL calculations.

ESALCALC is where you enter the traffic growth through the TRAFFIC GROWTH FACTOR. For 20-year designs and 2% traffic growth per year, the growth factor is 24.30. For 15-year designs and 2% traffic growth per year, the growth factor is 17.29. The formula for the TGF is:

((1+g)^n – 1)/(g)
Where g is the percent annual growth rate divided by 100 and n is the number of years).
So for g = 0.02 and n = 20 the GF is ((1+0.02)^20 – 1)/(0.02).
This is not automatically calculated in the ESALCALC spreadsheet so you need to do it yourself.

ESAL factors should not be modified from defaults.

B. Getting the required SN for design (SN_f) (future SN)

1. There is an excellent, free pavement design utility available on the Web.

http://pavementinteractive.org/index.php?title=Flexible_Pavement_Structural_Design_Utility

I have provided guidance in the table below for entering inputs into this equation.

Input	Value	Tool / Default values
W18 (ESALs)	-AADT and % Heavy Trucks (2-axle, 6-tire or greater, including buses) -Traffic Growth % per year -Design Life (Structural) -Directional distribution -Lane distribution	ESALCALC.xls Traffic Growth: 2% for all Design Life: Minimum 15 years required, Recommended 20 year minimum for higher-functional-class facilities Directional distribution: 50% default for two-directional traffic, 100% for one-way traffic (or double the AADT in spreadsheet) NOTE: ESALCALC.xls assumes 50% directional distribution already thus dividing the AADT by two. Lane distribution: 100% for 2-lane roads; 90% - 100% for 4-lane roads; 70-100% for 6+ lane roads
Soil Resilient Modulus (Mr)		Gravels: 10,000-12,000 psi Glacial Till: 10,000 psi Sands: 8,000 – 10,000 psi (Use lower values for "silty" or "clayey" sands) Silts: 7,000-8,000 psi Clays: 4,000-6,000 psi
Standard Deviation	0.45 for new construction	0.45 for new construction 0.49 for overlays
Reliability	Percent reliability of design	90%
Initial Minus Terminal Serviceability (Δ PSI)	Pavement Serviceability Index, PSI	4.2 initial PSI of hot-mix asphalt; Terminal PSI depends on importance of roadway:

		2.5 typical for higher-functional-class roadways; 2.0 for secondary roadways

Use these inputs when using the web-based tool mentioned above or the Excel pavement-design solution attached.

Both of these tools will give you the SN_f, the required future structural number.

C. The existing effective Structural Number

This is only necessary for rehabilitation (and mainline portion of widening).

SN_{eff} is typically obtained from a pavement condition survey (or remaining service life analysis) – this is discussed on Page III-105 of the pavement design guide and reproduced in the table immediately below. Remaining service life calculation is not recommended unless per the judgment of the pavement designer, because this analysis discounts "survivor" pavements (that have outlasted past ESAL accumulated loadings). The methodology is on Page III-107.

MATERIAL	SURFACE CONDITION	COEFFICIENT RANGE
AC Surface (hot mix asphalt, HMA)	Little or no alligator cracking and/or only low-severity transverse cracking	0.35 – 0.40 per inch
	< 10% low-severity allig ckg and/or <5% medium- and high-severity transverse cracking	0.25 – 0.35 per inch
	➢ >10% low-severity allg ckg and/or ➢ <10% medium-severity allig ckg and/or ➢ >5-10% medium- and high- severity trans. cracking	0.20 – 0.30 per inch
	➢ >10% medium-severity allg ckg and/or ➢ <10% high-severity allig ckg and/or ➢ >5-10% medium- and high- severity trans. cracking	0.14 – 0.20 per inch
	> 10% high-severity allig ckg and/or	0.08 – 0.15 per inch

	>10% high- severity transverse cracking	
Stabilized Base (includes HMA base)	Little or no alligator cracking and/or only low-severity transverse cracking	0.20 – 0.35 per inch
	< 10% low-severity allig ckg and/or <5% medium- and high-severity transverse cracking	0.15 – 0.25 per inch
	➢ >10% low-severity allg ckg and/or ➢ <10% medium-severity allig ckg and/or ➢ >5-10% medium- and high- severity trans. cracking	0.15 – 0.20 per inch
	➢ >10% medium-severity allg ckg and/or ➢ <10% high-severity allig ckg and/or ➢ >5-10% medium- and high- severity trans. cracking	0.10 – 0.20 per inch
	> 10% high-severity allig ckg and/or >10% high- severity transverse cracking	0.08 – 0.15 per inch
Granular Base or Subgrade	No evidence of pumping, degradation, or contamination by fines	0.10 – 0.14 per inch
	Some evidence of pumping, degradation, or contamination by fines	0.00 – 0.10 per inch

Any layers to be milled should be removed from the SN_{eff} calculation.

D. The provided SN is obtained as follows:

<u>For new/widened/reconstructed pavements:</u>

$SN = a_1D_1+a_2D_2m_2+a_3D_3m_3$

where the a's are layer coefficients representative of surface, base, and subbase courses,
D is the actual thicknesses (in inches) of surface, base, and subbase courses, respectively, and
m's are drainage coefficients for (granular) base and subbase layers, respectively.

(Use m_i = 1 unless you have site-specific information that can be used for Table 2.4 in the AASHTO guide, page II-25).

The layer coefficients for new materials:

0.44 per inch for HMA (HMA S0.5 or S0.375 in the surface layer, Bit. Conc. Class 1 if used)
0.40 per inch for Bituminous Concrete Class 2, if used

0.34 per inch for HMA S1 (or Bituminous Concrete Class 4, if used)

0.14 per inch for Processed Aggregate Base, and

0.11 for Subbase.

Do not assign layer coefficients to existing subgrade.

For rehabilitation designs:

$SN_{ol} = SN_f - SN_{eff}$

The SN_{ol} is composed of a combination of layer coefficients (a's) and thicknesses (D's) as in the new/windened/reconstructed pavements section.

E. Other structural design considerations:

Drainage: In areas of rock cut water must travel a longer path to leave the engineered pavement structure. We typically increase the depth of granular base (Subbase or Processed Aggregate Base) to 18%, and often recommend underdrain if necessary.

Frost protection – The total depth of the pavement structure (including hot-mix-asphalt and granular layers, including subbase) we use for State roads is 19", which is roughly 50% protection (this strikes a balance between cost-effectiveness and durability); for local roads this has been allowed to be less depending on site requirements (14" for reclaimed roads because of the technology; sidewalk heights / elevation constraints are other reasons the 19" guidance can be reduced; I would aim for 18" and reduce if necessary).

Reflective Cracking – Some pavements may be structurally accurate (SN_{ol} <= 0) but require repair of cracks; this is not addressed in the Guide – measures include milling, cold-in-place recycling, hot-in-place recycling.