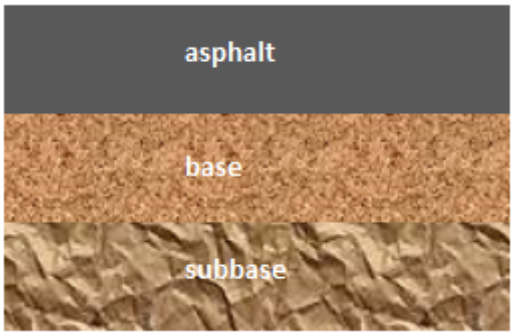
Highway Pavement Design using the CALTRANS Method

A highway pavement is several layers of material above the natural soil.



This application helps you design a flexible pavement using the approach outlined in the Highway Design Manual (6th edition) published by the California Department of Transportation (CALTRANS). Specifically, this application will determine the thickness of the subbase, base and asphalt concrete layers.

R-Value	"a measure of resistance of soils to deformation under wheel loading and saturated soils conditions"
Gravel Equivalent	"equivalent thickness of gravel (aggregate subbase) that would be required to prevent permanent deformation in the underlying layer or layers due to cumulative traffic loads anticipated during the design life of the pavement structure
Traffic Index	"a measure of the cumulative number of ESALs expected during the design life of the pavement structure"
Annual Average Daily Traffic	"average 24-hour volume, being the total number during a stated period divided by the number of days in that period"
Equivalent Single Axle Loads	"number of 18-kip standard single axle load repetitions that would have the same damage effect to the pavement as an axle of a specified magnitude and configuration"

Excerpts from HDM 6th edition

Function to round lengths to the next highest 0.05 ft

$$\text{roundhigh} := x \;\; \text{ifelse}(\text{frac}(10\cdot x) > 0.5\text{ft}, 0.1\cdot\text{ceil}(10\cdot x), 0.1\cdot(\text{floor}(10\cdot x) + 0.5\text{ft}))$$

California R-value of the material

Soil	$R_{soil} := 10$
Subbase	$R_{sub} := 50$
Base	$R_{base} := 78$

Gravel equivalent factor of structural layers

Subbase	$G_{fsub} := 1$
Base	$G_{fbase} := 1.1$

Annual average daily traffic values

2-axle truck	$ADT_2 := 935$
3-axle truck	$ADT_3 := 550$
4-axle truck	$ADT_4 := 225$
5-axle truck	$ADT_5 := 1025$

Lane distribution factor (Table 613.3B HDM)

Number of mixed flow lanes in one direction: $LDF := 1$

18-kip equivalent single axle load for the surface (Table 613.3A HDM)

30-year constants

$$ESAL := 2070 \times ADT_2 + 5520 \times ADT_3 + 8820 \times ADT_4 + 20670 \times ADT_5 = 28142700$$

Traffic index (Table 613.3B HDM)

$$TI := 9.0 \times \left(\frac{ESAL \times LDF}{10^6} \right)^{0.119} = 13.388$$

Gravel equivalents (630-6 c & d HDM)

Asphalt concrete layer	$GE_{asp} := 0.0032 \times TI \times (100 - R_{base})\ ft = 0.943\ ft$
Asphalt and base combined	$GE_{asp\_base} := 0.0032 \times TI \times (100 - R_{sub})\ ft = 2.142\ ft$
Asphalt, base and subbase combined	$GE_{asp\_base\_sub} := 0.0032 \times TI \times (100 - R_{soil})\ ft = 3.856\ ft$

Gravel factor for asphalt $G_{fasp} := \frac{5.67}{\sqrt{TI}} = 1.550$

Actual equivalent thickness (630-7e HDM)

Calculated thicknesses have a minimum of 0.35 ft and round up to the nearest 0.05 ft

Thickness of the asphalt concrete

$t_{asp} := \text{roundhigh}\left(\max\left(GE_{asp}/G_{fasp}, 0.35\,\text{ft}\right)\right)$

$t_{asp} = 0.650\,\text{ft}$

Gravel thickness of the base

$t_{base} := \text{roundhigh}\left(\max\left(\left(GE_{asp\_base} - GE_{asp}\right)/G_{fbase}, 0.35\,\text{ft}\right)\right)$

$t_{base} = 1.100\,\text{ft}$

Gravel thickness of the subbase

$t_{sub} := \text{roundhigh}\left(\max\left(\left(GE_{asp\_base\_sub} - GE_{asp\_base}\right)/G_{fsub}, 0.35\,\text{ft}\right)\right)$

$t_{sub} = 1.750\,\text{ft}$

Total section thickness

$t_{sec} := t_{asp} + t_{base} + t_{sub} = 3.500\,\text{ft}$