Project: Keaau-Pahoa Road Improvements - Route 130 (Shower Drive to Ainaloa Boulevard) (Alternative #1)

Pavement Design

Reference: Pavement Design Manual, State of Hawaii, Department of Transportation, dated Revised May 1995, revised March 2002.

Assumptions:

Pavement type	ACP	
Design life	50	years
Directions of traffic	2	[enter 1 for 1-way or 2 for 2-way traffic]
Directional distribution	75	%
ADT (yr 2018)	28300	two direction traffic
ADT (yr 2068)	55800	two direction traffic
Average ADT	42050	two direction traffic (calculated or direct input value)
T24	3.5	%
No. of lanes in one direction	2	
Percent of 2-axle trucks	63.03	%
Percent of 3-axle trucks	16.33	%
Percent of 4-axle trucks	11.22	%
Percent of 5-axle trucks	7.54	%
Percent of 6-axle trucks	1.88	%
Abbreviation for base material	ACB	[AB, ACB, ATPB, UPB, ###, or none
Name of base if not AB, etc.	n/a	[enter name if abbreviation for base material is ###, otherwise n/a]
Gf of base, if not AB, etc.	n/a	[enter gravel factor if base is not AB, ACB, ATPB, or UPB, otherwise n/a]
R-value of base, if not AB, etc.	n/a	[enter R-value if base is not AB, ACB, ATPB, or UPB, otherwise n/a]
GE safety factor, if not AB, etc.	n/a	[enter GE safety factor if base is not AB, ACB, ATPB, or UPB, otherwise n/a]
Abbreviation for subbase material	none	[ASB,---(material other than ASB, see next entry)] or none
Name of subbase if not ASB	n/a	[enter name if abbreviation for subbase material is ---, otherwise n/a]
Gf of subbase, if not ASB	n/a	[enter gravel factor if subbase is not ASB, otherwise n/a]
R-value of subbase, if not ASB	n/a	[enter R-value if subbase is not ASB, otherwise n/a]
Subgrade material	SG	
Name of subgrade	gravel	[enter name]
R-value of subgrade	55	[enter R-value]

Given Design Lane Factors (DLF)

Number of lanes in one direction	DLF
1	1
2	1
3	0.8
4	0.75

Given ESALC, constants for equivalent 18 kip single axle load (Section 3.2.2.1 from reference)

No. of truck axles	one direction constants
2-axle trucks	65
3-axle trucks	525
4-axle trucks	1,162
5-axle trucks	1,462
6-axle trucks	968

Given gravel factor and R-value for subbases and bases (Table 1-A from reference)

Abbrev.	Desc.		Gravel Factor Gf	R-value	
AB	Aggregate base		1.1	80	
ACB	Asph. conc. base		*	90	* 0.95 x Gf for ACP
ATPB	Asphalt. treated permeable base		1.4	60	
UPB	Untreated permeable base		1.1	55	
ASB	Aggregate subbase		1.0	60	
###	ACB	---	n/a	n/a	
---	none	subbase	n/a	n/a	
SG	gravel	subgrade	---	55	
-	no base				
--	no subbase				
ACP	Asphaltic concrete pavement				

Given GE, gravel equivalent safety factors (Table 3-A from reference)

Base Type	GE increase (ft)	Add to
ACB	0.24	ACP
ATPB	0.24	ACP
AB	0.2	ACP
UPB	0.2	ACP
none	0.1	ACP

Calculations:

Design ADT (two directions)	42050	
Percent trucks	3.5	%
Total trucks	1471.75	

1. Determine total ESAL, equivalent 18 kip single axle load [ADTT x ESALC x design life, for all trucks]

	---		---		design life (yrs)		ESALC		subtotal
ESAL for 2-axle trucks:	63.03369663	x	1471.75	x	50	x	65	=	3,015,020
ESAL for 3-axle trucks:	16.32836716	x	1471.75	x	50	x	525	=	6,308,210
ESAL for 4-axle trucks:	11.21887811	x	1471.75	x	50	x	1,162	=	9,593,114
ESAL for 5-axle trucks:	7.539246075	x	1471.75	x	50	x	1,462	=	8,111,092
ESAL for 6-axle trucks:	1.879812019	x	1471.75	x	50	x	968	=	1,339,041
Total ESAL for all vehicles									28,366,477

2. Determine total design ESAL for all vehicles [Total ESAL for all vehicles x DLF x Directional Distribution]

Total ESAL:	28,366,477	x	1	x	0.75	=	21,274,857

3. Determine TI, traffic index [9 x ((total ESAL/1000000)^0.119)]

TI	12.95
TI (rounded to nearest 0.5)	13

4. Determine asphalt thickness

a. Determine R-value of material to be covered

Abbreviation of material to be covered	ACB
Description of material to be covered	Asph. conc. base
R-value, from Table 1-A	90

b. Determine GE, gravel equivalent factor [0.0032 x TI x (100-R)] (Equation 3.1 from reference)

GE, w/o safety factor	0.416
Add GE safety factor, from Table 3-A	0.240
GE with safety factor	0.656

c. Determine assumed Gf of pavement material, (acp)

assume Tacp =	4	inches
assume Tacb =	8	inches
Gf (acp) =	1.941	

d. Determine Tacp (GEacp/Gfacp) and compare to assumed Tacp

Tacp = 4.055 inches

Use Tacp	4.0	inches (rounded up to the nearest 0.5 inch)
(Minimum thickness should be 2.5" for AC layer)		

e. Determine GE of Final Tacp (Tacp x Gfacp)

Gf for Final Tacp	1.941
GE of Final Tacp	0.647
GE of Final Tacp less GE safety factor	0.407

5. Determine base thickness

a. Determine R-value of material to be covered

Abbreviation of material to be covered	SG
Description of material to be covered	gravel
R-value, from Table 1-A or as assumed	55

b. Determine GE, gravel equivalent factor, GE=(0.0032 x TI x (100-R))

GE, w/o safety factor	1.872
Less GE of Tacp (Tacp/Gfacp)	-0.407
Adjustment for GE safety factor included in Tacp	-0.240
GE less GE of Tacp and safety factor	1.225

c. Determine Gf of base material, from Table 1-A 1.844

d. Calculate Tbase (GEbase/Gfbase) 0.664 feet or 8 inches

Use Tbase	8.0	inches (rounded up to the nearest inch except for acb)
(Minimum thickness should be 4" for acb and 6" for aggregate base or permeable base)		

Therefore, final pavement section is:

4.0	inches	Asphaltic concrete pavement
8.0	inches	Asph. conc. base (or Glassphalt conc. Base)
12.0	inches	Total