PAVEMENT VARIANCE

FOR

NEWHAVEN SUBDIVISION

IN

MANOR, TEXAS

QUIDDITY

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Austin, Texas 78741
Tel: 512.441.9493
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MAY 2024

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INTRODUCTION

Quiddity engineering is submitting this pavement variance request in accordance with the City of Manor's guidelines and municipal code. Quiddity Engineering understands the importance of maintaining a balance between adherence to regulations and the accommodation of unique property conditions. This variance seeks to present proposed variance to the City of Manor's pavement design guidelines that the City will find acceptable.

Project No. AAA23-130-00
Revision No. 3, April 15, 2024

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Gregg Lane Land Dev, LLC

c/o: Mr. Travis Janik
Project Manager – Land Development
101 Parklane Boulevard, Suite 102
Sugar Land, Texas 77478

RE: Supplemental Pavement Recommendations
Newhaven Subdivision
Gregg Lane
Manor, Texas

Dear Mr. Janik:

RABA KISTNER Consultants, Inc. (RKCI) is pleased to submit this supplemental letter providing supplemental pavement recommendations for the design of local residential streets and Anderson Road to be located in the Newhaven Subdivision in Manor, Texas. Per review comments by Ms. Pauline Gray, P.E., with GBA, and e-mail correspondence with Mr. Brad Carabajal, P.E., with Quiddity, we understand that the City of Manor is open to alternative designs that do not meet the City of Austin Transportation Criteria Manual PVR limits of 3 in. for local/residential and 2 in. for collector roadways. However, the city has emphasized that options that reduce the frequency/severity of maintenance should be prioritized. **Pros and cons are tabulated following a brief description of modifications in our traffic assumptions and a high-level discussion of state-of-the-practice flexible pavement philosophy.**

This letter supplements our geotechnical engineering report for *Newhaven Subdivision*, dated December 1, 2023 (RKCI Project No. AAA23-130-00), and should not be used separately from the original report.

TRAFFIC INFORMATION

The City of Austin Transportation Criteria Manual was utilized for estimating the 20-yr design 18-kip Single Axle Loads (ESALs). Although the Manor Thoroughfare Plan December 2022 indicates that Anderson Road is a future "minor arterial" (corresponding to "Urban Arterial Low Traffic"), per comments by GBA, we understand that Anderson Road has since been reclassified as an "Urban Collector". The City of Austin sorts urban collectors into "High Traffic" and "Low Traffic". Based on the Manor Thoroughfare Plan and GBA's comments, and to increase pavement resiliency, we have selected the "High Traffic" option. A summary of the ESAL values used for design of the roadway pavement sections is presented in the table below.

Roadways	Street Classification	Initial Average Daily Traffic (ADT) Range/Value Used	20 Year Design ESALs
General Residential Streets	Urban Local	200 to 3,000 (1,500)	150,000
Anderson Road	Urban Collector High Traffic	2,000 to 8,000 (5,000)	2,100,000

DESIGN METHOD AND PARAMETERS

Pavement design was performed in general accordance with the recommendations presented in the City of Austin Transportation Criteria Manual, which generally defers to the CAPEC Pavement Design Manual.

The computer program FPS 21 was utilized for evaluating the required flexible pavement thickness. FPS 21 is a mechanistic-empirical design procedure evaluating pavement performance based on serviceability index and traffic loading. Similar to AASHTO 93, FPS 21 uses reliability (confidence level) approach to account for variability. The FPS 21 design parameters utilized in our analyses are shown in the table below. Printouts of the FPS 21 results are attached.

FPS 21 Design Parameters	General Residential Streets	Anderson Road
Confidence Level	B (90%)	C (95 %)
Initial Serviceability Index	4.2	4.5
Final Serviceability Index	2.0	3.0
Analysis Period (yr)	20	20
Design Modulus (ksi)		
Dense-Graded Hit-Mix Asphalt	500	650
Flexible Base	40	40
Lime-Treated Subgrade	20	20
Subgrade	8	8
Imported Low PI Subgrade	20	20

RECOMMENDED PAVEMENT SECTIONS

The following pavement sections are recommended for general residential streets and Anderson Road. The resultant PVR values for the recommended pavement section options below are also presented. A discussion of the City of Austin Transportation Criteria Manual requirements, solutions historically posed in central Texas for improving poor subgrade conditions, and the merits and demerits of the recommended options is presented in a later section.

All pavement sections presented below are adequate in supporting HS-20 loading including an 80,000-lb fire truck having 16,000-lb point loads.

General Residential Streets (Urban Local)

Layer Description	Layer Thickness	
	Option 1 – Overexcavation Option (Baseline) PVR = 3 in.	**Option 2 – Lime Treatment Option PVR = 4 in.**
HMAC Surface Course, Type "C" or "D"	2.0 in.	2.0 in.
Flexible Base	11.0 in.	14.0 in.
Geogrid	Optional	- -
Lime Treated Subgrade	- -	8.0 in.
Low PI Fill	35.0 in.	- -
Combined Total	**48.0 in.**	**24.0 in.**

Due to the updated street classification and ESALs, the options provided below cannot be directly compared with those provided in our original geotechnical report or prior revisions of this supplemental pavement study.

Anderson Road (Urban Collector High Traffic)

Layer Description	Layer Thickness	
	Option 1 – Overexcavation Option (Baseline) PVR = 2 in.	**Option 2 – Lime Treatment Option PVR = 4 in.**
HMAC Surface Course, Type "C" or "D"	2.5 in.	2.5 in.
HMAC Base Course, Type "B" or "C"	3.0 in.	3.0 in.
Flexible Base	12.0 in.	14.0 in.
Geogrid	Optional	Yes*
Lime Treated Subgrade	- -	8.0 in.
Low PI Fill	4 ft 7 in.	- -
Combined Total	**72.5 in.**	**27.5 in.**

*Option 2 geogrid reinforcement shall have full-scale testing performance equal to or exceeding that of Tensar TX-5

DISCUSSION OF OPTIONS

In the latest City of Austin Transportation Criteria Manual (dated July 12, 2022), Appendix B Section 5.2.2, upper PVR limits of 2 inches for arterials and collectors and 3 inches for local and residential streets are provided as subgrade performance criteria. Option 1 for each classification of roadway above reduces the PVR to these stated performance criteria.

Historically (prior to 2022), the City of Austin recommended improvement of subgrade soils with plasticity indices (PI) greater than 25. In Section 3.1.3 of the Transportation Criteria Manual (dated August 7, 2020), "the design professional is advised to adopt at least one and preferably a combination of the following measures":

- Replacement of the upper 18 inches of subgrade with low PI soils (PI less than 15 and more than 4);
- Use of lime, cement, or lime/cement treatment to a depth of 8 to 24 in.;
- Use of moisture barriers, such as sidewalks and driveways; and/or
- Reinforcement with geogrid.

Of these options, the first two reduce the inherent swell potential of the soils, the third reduces access for moisture to enter/exit the subgrade, and the last reduces the effects of swelling soils on the overall pavement structure. Lime treatment also provides an impermeable layer that can, when properly constructed, provide moisture separation of the asphalt and flexible base from the underlying subgrade, as well as providing a firm construction platform in soft/wet subgrade area. In our experience, geogrid reinforcement can provide lateral confinement of the base materials, increasing the effective modulus of the overlying flexible base materials while still leaving the roadway free to flex due to expansive clays. This flexibility makes the pavement system more able to resist cracking due to seasonal moisture fluctuations in the subgrade.

Not all geogrid reinforcement provides the same increase in pavement resiliency. RKCI recommends that the owner select a geogrid reinforcement product that has been proven in an independent study to be effective in full-scale load testing. For this reason, we recommend consideration of products from Tensar or Solmax.

PVR and Maintenance

In our local experience, geogrid reinforcement, particularly when combined with light subgrade improvement such as lime treatment, can result in a favorable substitute to overexcavation and low PI fill replacement, which has historically been uncommon, particularly in high swell regions (such as the Navarro and Taylor Group soils at this site). This is particularly true when good drainage (crowned roadways with curb and gutter) is promoted, and a regular maintenance program is implemented. Sealing cracks in the asphalt pavement as they occur reduces infiltration of surface moisture into the flexible base, which in turn may result in softening of the flexible base and subgrade, accelerating pavement fatigue.

Maintenance of roadways, including crack sealing of the pavement, is recommended regardless of what measures are taken to reduce fatigue of the pavement structure. Spending more on PVR reduction during initial construction may not result in an overall cost savings over the lifetime of the pavement, and should not be taken as a substitute for a regular pavement inspection and maintenance program. Particularly in areas with poor drainage, or where geogrid reinforcement is not used, expansive soils may cause reflective cracking through lime treated soils and/or flexible base even when site PVR is reduced, in turn resulting in longitudinal cracking in the asphalt.

Comparison of Options

Although reduction of the soil swell potential by overexcavation and replacement with low PI soils is very effective in reducing swell related damage to pavement materials, the costs of hauling and importing soils with low expansive potential may result in excessive material hauling and material costs as well as construction duration. (The environmental impact of mass material hauling may also be a consideration.) We recommend that the City consider alternatives that reduce costs while providing similar pavement life and/or serviceability.

Option 2 has been provided as a section representing RK standard practice. Cost benefit or life cycle cost analysis is beyond the scope of this report.

As an additional performance enhancement option, we also recommend that curbs that fully penetrate the flexible base be used. Ribbon curbs are one option that provides a small horizontal moisture barrier.

Pros and Cons

The following table presents a summary of the information above.

	Option 1	Option 2
Pros	• Reduces PVR to City of Austin TCM App. B Section 5.2.2 criterion • Good candidate for mill and overlay pavement rehabilitation (may involve complete removal of asphalt for local roads) • Modifies subgrade to a relatively large depth (48 and 72 in. for local and collector roads), replacing poor subgrade • Improves high PI subgrade as described in the old Austin TCM (2020) Section 3.1.3 • If included, curb and gutter will promote good drainage and provide a moisture barrier to protect the flexible base	• Good candidate for mill and overlay pavement rehabilitation (may involve complete removal of asphalt for local roads) • Provides lime treatment moisture separation barrier/ buffer • Provides subgrade modification by treatment of soil instead of material export • Modifies soil to a relatively low depth (24 and 27 in. for local and collector roads), reducing export/import and construction time • In general accordance with historically accepted pavements in the central Texas area • Improves high PI subgrade as described in the old Austin TCM (2020) Section 3.1.3 • (Anderson Road) Incorporates geogrid reinforcement to improve base confinement/reinforcement • If included, curb and gutter will promote good drainage and provide a moisture barrier to protect the flexible base
Cons	• Requires a maintenance program to ensure good pavement performance over time • Requires relatively greater export and import of soils, which has both monetary and environmental costs and will increase construction time • Not a historically performed subgrade improvement in the central Texas area • In areas without good drainage, water can collect within the low PI fill (“bathtub effect”), softening fill and increasing risk of swell greater than estimated PVR	• Does not reduce PVR to City of Austin TCM App. B Section 5.2.2 criterion • Risk of sulfate-induced heaving if high sulfate subgrade is present • Requires a maintenance program to ensure good pavement performance over time • In the absence of geogrid, lime treated subgrade may grow brittle and reflectively crack through asphalt

* * * * * * * * * * * * * * * * * *

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Richard T. Shimono, P.E.
Project Manager

Yvonne Garcia Thomas, P.E.
Vice President

4/15/2024

MPB/YGT/RTS: jm

Copies Submitted: Above (1-electronic)
Attachments: FPS-21 Output Files

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/4/2024**	**1**

COMMENTS ABOUT THIS PROBLEM

Newhaven Residential - Option 1

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	20.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	10.0
DESIGN CONFIDENCE LEVEL (90.0%)	B
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.2
FINAL SERVICEABILITY INDEX P2	2.0
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	8.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	1500.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	2700.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	0.150
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	70.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	50.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	4.0

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/4/2024**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	0.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	1
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	MATERIALS CODE	NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	A	ASPH CONC PVMT	150.00	500000.	0.35	2.00	2.00	30.00
2	B	FLEXIBLE BASE	54.00	40000.	0.35	11.00	12.00	75.00
3	C	LOW PI SOIL	15.00	20000.	0.30	35.00	36.00	90.00
4	D	SUBGRADE(200)	2.00	8000.	0.40	200.00	200.00	90.00

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

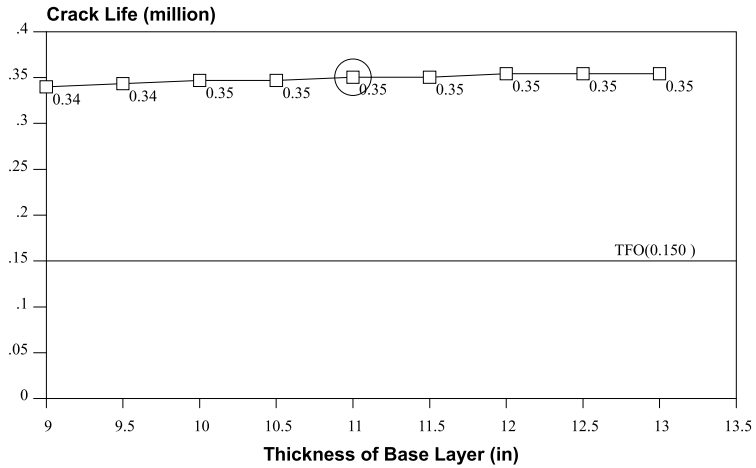
PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/4/2024**	**3**

C. LEVEL B SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST
1

MATERIAL ARRANGEMENT	ABC
INIT. CONST. COST	39.42
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.00
SALVAGE VALUE	-7.24
TOTAL COST	32.18
NUMBER OF LAYERS	3
LAYER DEPTH (INCHES)	
D(1)	2.00
D(2)	11.00
D(3)	35.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	40.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 12

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	2.00	500.00	0.35	ASPH CONC PVMT
Base	11.00	40.00	0.35	FLEXIBLE BASE
Subbase	35.00	20.00	0.30	LOW PI SOIL
Subgrade	200.00	8.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

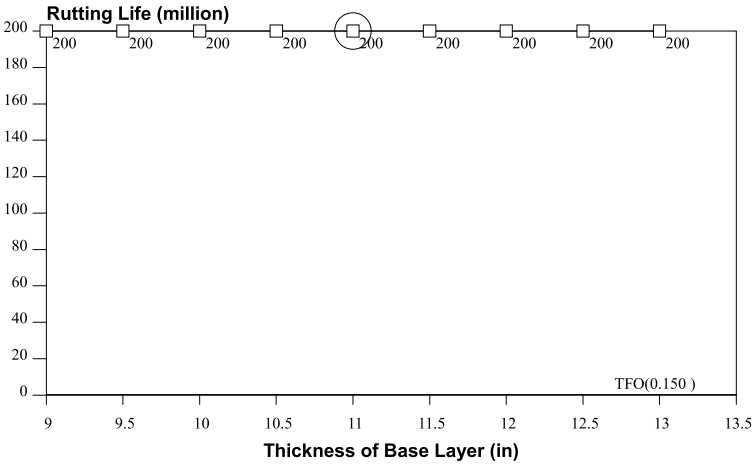
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477



TFO(Traffic to 1st Overlay): 0.15 (million)

Crack Life: 0.35 (million) ε_τ = 318.00 (με)

Rut Life: 200.00 (million) ε_v = -124.00 (με)

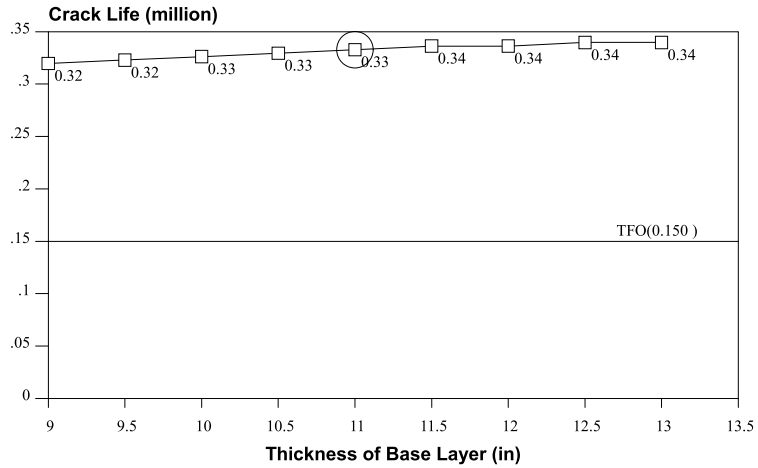
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:.15millions.
Also the start ADT:1500.0 and ending ADT:2700.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/4/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	2.00	500.00	0.35	ASPH CONC PVMT
Base	11.00	40.00	0.35	FLEXIBLE BASE
Subgrade	200.00	20.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

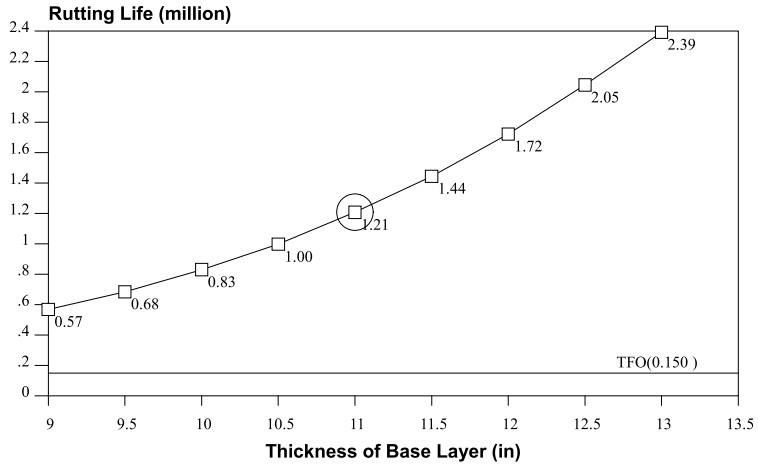
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477



TFO(Traffic to 1st Overlay): 0.15 (million)

Crack Life: 0.33 (million) ε_τ = 323.00 (με)

Rut Life: 1.21 (million) ε_v = -459.00 (με)

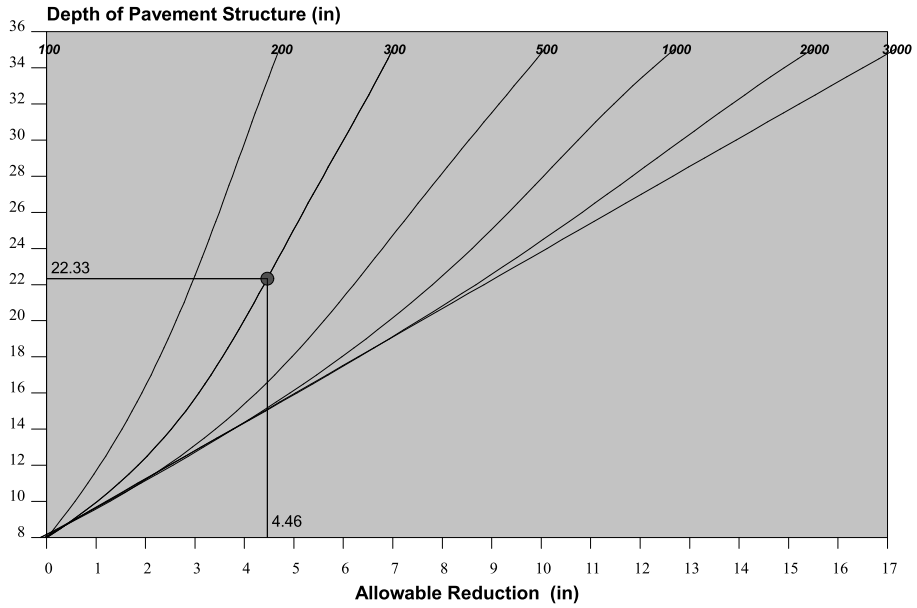
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:.15millions.
Also the start ADT:1500.0 and ending ADT:2700.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/4/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	2.00	500.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	11.00	40.00	0.35	FLEXIBLE BASE
LOW PI SOIL	35.00	20.00	0.30	LOW PI SOIL
SUBGRADE(200)	200.00	8.00	0.40	SUBGRADE(200)
Bed Rock		800.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	10000.0 (lb)
Percentage of TandemAxles	49.0 (%)
Modified Cohesionmeter Value	300.0
Design Wheel Load	10000.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.80

TTC is based on Texas County Soil Database for (TRAVIS)

For soils type : clay of high plasticity, fat clay(CH)

RESULT:

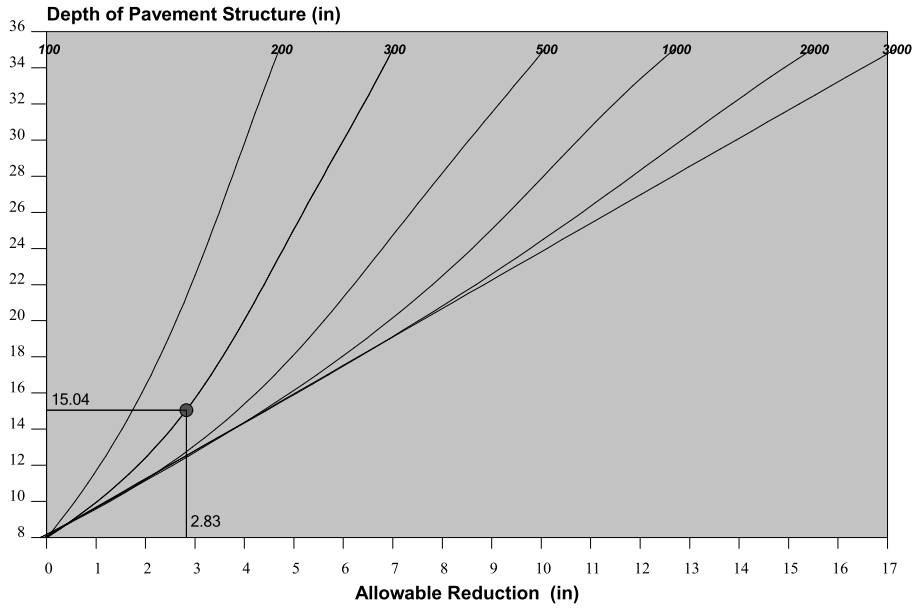
Triaxial Thickness Required	22.3 (in)
The FPS Design Thickness	48.0 (in)
Allowable Thickness Reduction	4.5 (in)
Modified Triaxial Thickness	17.9 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output		**(FPS21-1.5Release:12-12-2018)**	
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/4/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	2.00	500.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	11.00	40.00	0.35	FLEXIBLE BASE
SUBGRADE(200)	200.00	20.00	0.40	SUBGRADE(200)
Bed Rock		2000.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	10000.0 (lb)
Percentage of TandemAxles	49.0 (%)
Modified Cohesionmeter Value	300.0
Design Wheel Load	10000.0 (lb)
Subgrade Texas Triaxial Class Number (TTC) Calculated TTC based on input soil PI	4.55
User Input Sub-Grade Plasticity Index (PI)	20.00

RESULT:

Triaxial Thickness Required	15.0 (in)
The FPS Design Thickness	13.0 (in)
Allowable Thickness Reduction	2.8 (in)
Modified Triaxial Thickness	12.2 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/4/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base over Subgrade			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**1**

COMMENTS ABOUT THIS PROBLEM

Newhaven Residential - Option 2

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	20.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	10.0
DESIGN CONFIDENCE LEVEL (90.0%)	B
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.2
FINAL SERVICEABILITY INDEX P2	2.0
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	8.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	1500.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	2700.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	0.150
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	70.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	50.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	4.0

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	0.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	1
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	MATERIALS CODE	NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	A	ASPH CONC PVMT	150.00	500000.	0.35	2.00	2.00	30.00
2	B	FLEXIBLE BASE	54.00	40000.	0.35	14.00	14.00	75.00
3	C	LIME TREATED SUBGR	15.00	20000.	0.30	8.00	8.00	90.00
4	D	SUBGRADE(200)	2.00	8000.	0.40	200.00	200.00	90.00

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

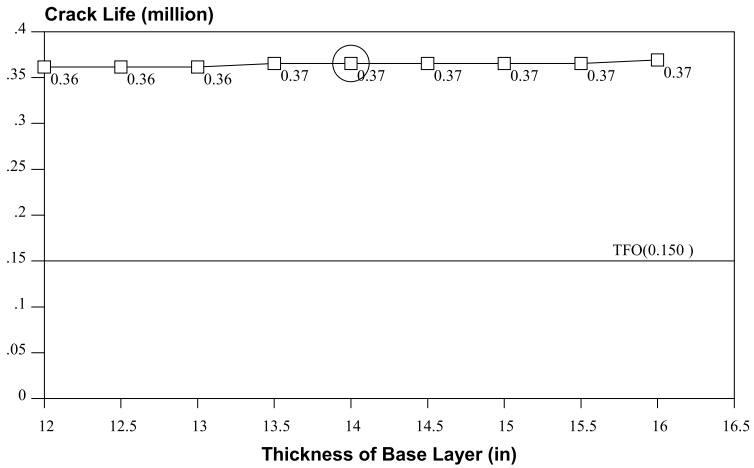
PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**3**

C. LEVEL B SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST
1

MATERIAL ARRANGEMENT	ABC
INIT. CONST. COST	32.67
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.00
SALVAGE VALUE	-5.49
TOTAL COST	27.18
NUMBER OF LAYERS	3
LAYER DEPTH (INCHES)	
D(1)	2.00
D(2)	14.00
D(3)	8.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	40.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 1

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	2.00	500.00	0.35	ASPH CONC PVMT
Base	14.00	40.00	0.35	FLEXIBLE BASE
Subbase	8.00	20.00	0.30	LIME TREATED SUBGRADE
Subgrade	200.00	8.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

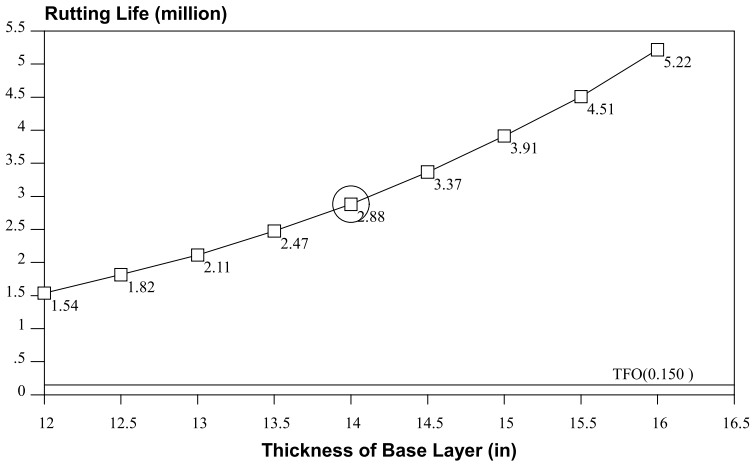
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477



TFO(Traffic to 1st Overlay): 0.15 (million)

Crack Life: 0.37 (million) ε_τ = 314.00 (με)

Rut Life: 2.88 (million) ε_v = -378.00 (με)

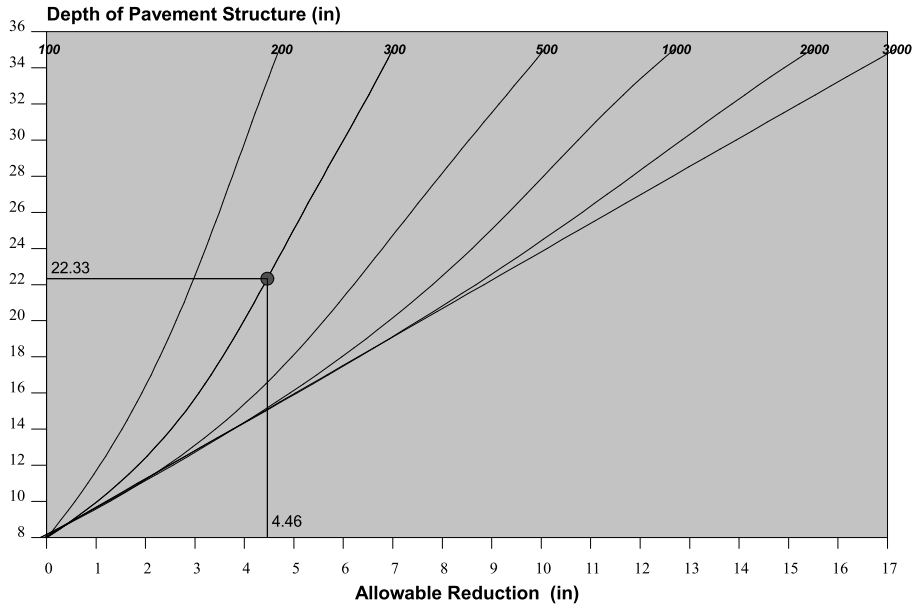
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:.15millions.
Also the start ADT:1500.0 and ending ADT:2700.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	2.00	500.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	14.00	40.00	0.35	FLEXIBLE BASE
LIME TREATED SUBGRADE	8.00	20.00	0.30	LIME TREATED SUBGRADE
SUBGRADE(200)	200.00	8.00	0.40	SUBGRADE(200)
Bed Rock		800.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	10000.0 (lb)
Percentage of TandemAxles	49.0 (%)
Modified Cohesionmeter Value	300.0
Design Wheel Load	10000.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.80

TTC is based on Texas County Soil Database for (TRAVIS)

For soils type : clay of high plasticity, fat clay(CH)

RESULT:

Triaxial Thickness Required	22.3 (in)
The FPS Design Thickness	24.0 (in)
Allowable Thickness Reduction	4.5 (in)
Modified Triaxial Thickness	17.9 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**1**

COMMENTS ABOUT THIS PROBLEM

Newhaven Arterial (Anderson (Option 1))

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	20.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	10.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	3.0
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	8.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	5000.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	10950.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	2.100
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	70.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	50.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	8.0

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	0.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	1
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	MATERIALS CODE	NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	A	ASPH CONC PVMT	150.00	650000.	0.35	5.50	6.00	30.00
2	B	FLEXIBLE BASE	54.00	40000.	0.35	12.00	16.00	75.00
3	C	LOW PI FILL	15.00	20000.	0.30	48.00	48.00	90.00
4	D	SUBGRADE(200)	2.00	8000.	0.40	200.00	200.00	90.00

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

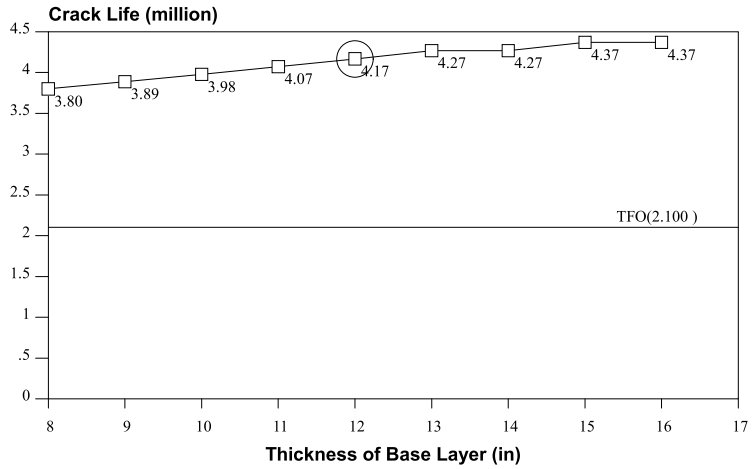
PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**3**

C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST
1

MATERIAL ARRANGEMENT	ABC
INIT. CONST. COST	60.92
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.00
SALVAGE VALUE	-9.92
TOTAL COST	51.00
NUMBER OF LAYERS	3
LAYER DEPTH (INCHES)	
D(1)	5.50
D(2)	12.00
D(3)	48.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	20.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 19

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	5.50	650.00	0.35	ASPH CONC PVMT
Base	12.00	40.00	0.35	FLEXIBLE BASE
Subbase	48.00	20.00	0.30	LOW PI FILL
Subgrade	200.00	8.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

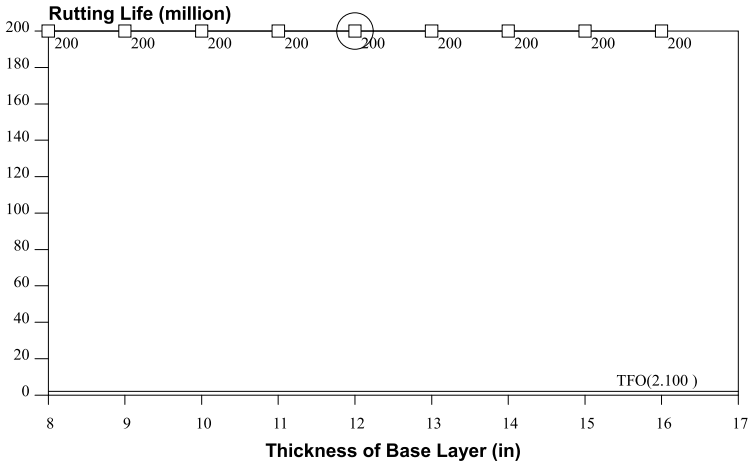
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477



TFO(Traffic to 1st Overlay): 2.10 (million)

Crack Life: 4.17 (million) ε_τ = 140.00 (με)

Rut Life: 200.00 (million) ε_v = -64.30 (με)

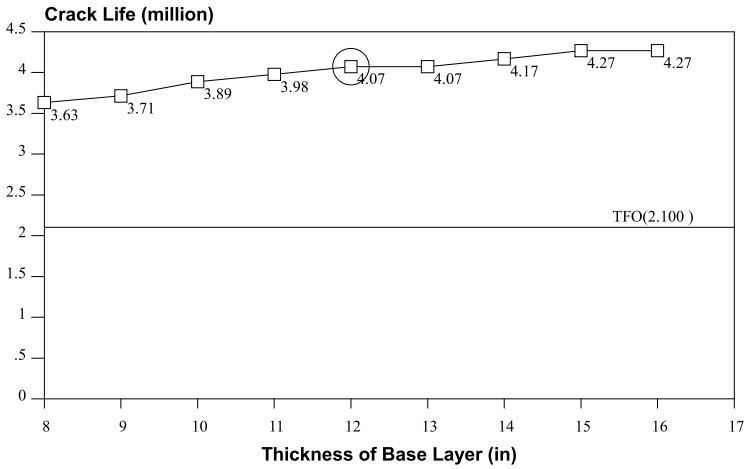
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.10millions.
Also the start ADT:5000.0 and ending ADT:10950.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	5.50	650.00	0.35	ASPH CONC PVMT
Base	12.00	40.00	0.35	FLEXIBLE BASE
Subgrade	200.00	20.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$

f_1 =7.96E-02

f_2 = 3.291

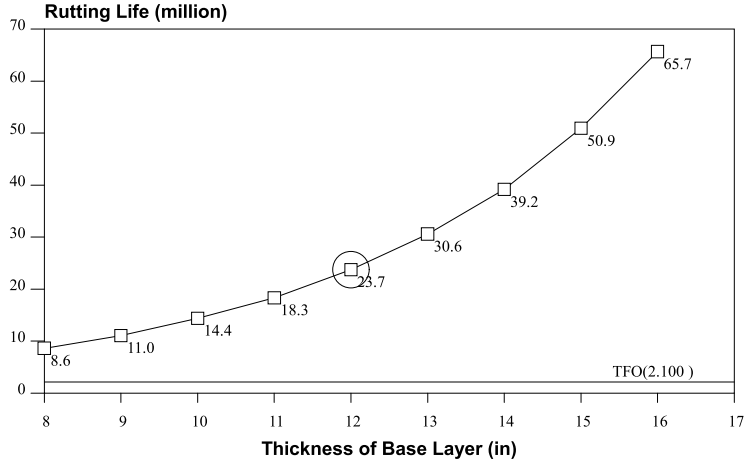
f_3 = .854

Rutting Model:

$N_d = f_4 (\varepsilon_v)^{-f_5}$

f_4 =1.37E-09

f_5 = 4.477



TFO(Traffic to 1st Overlay): 2.10 (million)

Crack Life: 4.07 (million) ε_τ = 141.00 (με)

Rut Life: 23.72 (million) ε_v = -236.00 (με)

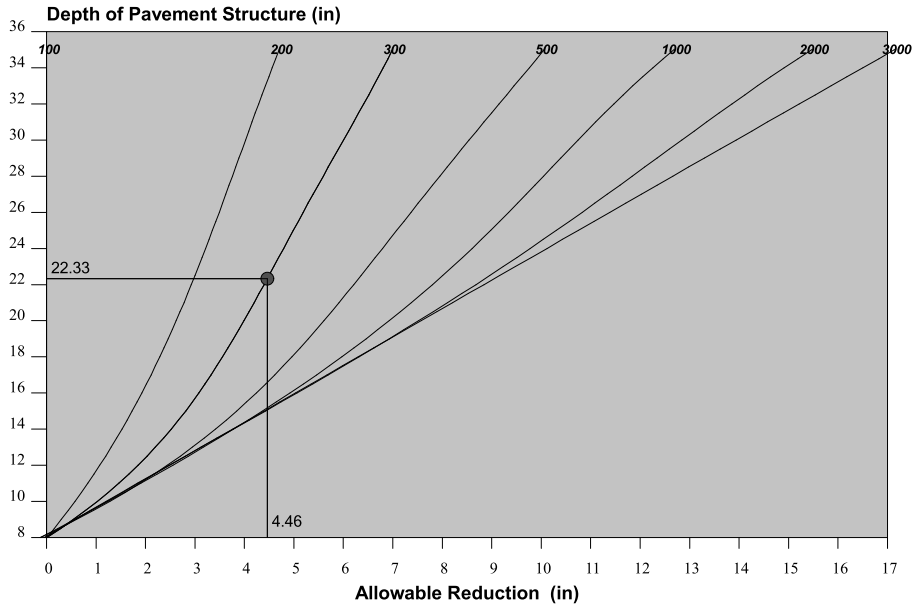
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.10millions.
Also the start ADT:5000.0 and ending ADT:10950.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	5.50	650.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	12.00	40.00	0.35	FLEXIBLE BASE
LOW PI FILL	48.00	20.00	0.30	LOW PI FILL
SUBGRADE(200)	200.00	8.00	0.40	SUBGRADE(200)
Bed Rock		800.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	10000.0 (lb)
Percentage of TandemAxles	49.0 (%)
Modified Cohesionmeter Value	300.0
Design Wheel Load	10000.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.80

TTC is based on Texas County Soil Database for (TRAVIS)

For soils type : clay of high plasticity, fat clay(CH)

RESULT:

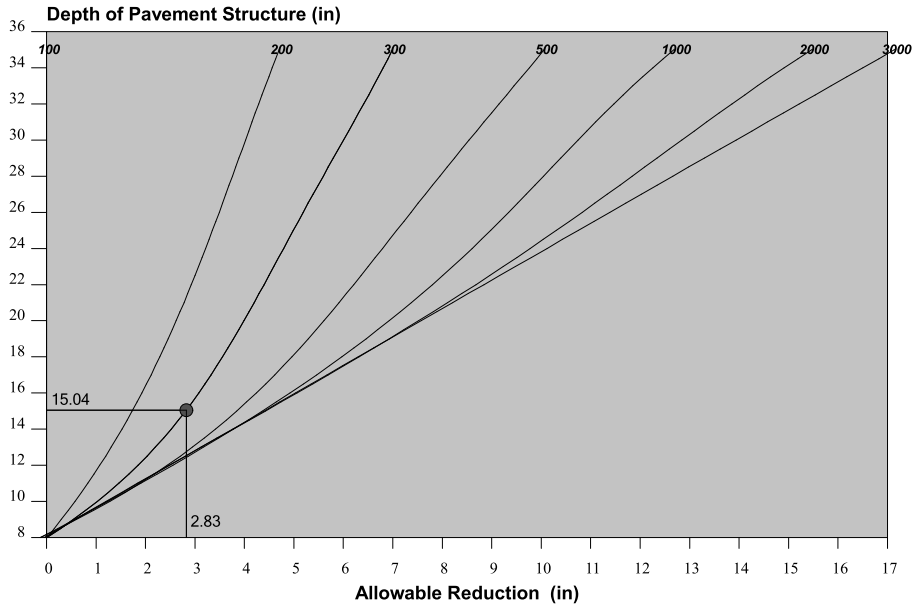
Triaxial Thickness Required	22.3 (in)
The FPS Design Thickness	65.5 (in)
Allowable Thickness Reduction	4.5 (in)
Modified Triaxial Thickness	17.9 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	5.50	650.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	12.00	40.00	0.35	FLEXIBLE BASE
SUBGRADE(200)	200.00	20.00	0.40	SUBGRADE(200)
Bed Rock		2000.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	10000.0 (lb)
Percentage of TandemAxles	49.0 (%)
Modified Cohesionmeter Value	300.0
Design Wheel Load	10000.0 (lb)
Subgrade Texas Triaxial Class Number (TTC) Calculated TTC based on input soil PI	4.55
User Input Sub-Grade Plasticity Index (PI)	20.00

RESULT:

Triaxial Thickness Required	15.0 (in)
The FPS Design Thickness	17.5 (in)
Allowable Thickness Reduction	2.8 (in)
Modified Triaxial Thickness	12.2 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base over Subgrade			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**1**

COMMENTS ABOUT THIS PROBLEM

Newhaven Arterial (Anderson (Option 2)

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	20.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	10.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	3.0
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	8.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	5000.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	10950.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	2.100
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	70.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	50.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	8.0

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	0.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	1
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	MATERIALS CODE	NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	A	ASPH CONC PVMT	150.00	650000.	0.35	5.50	5.50	30.00
2	B	FLEXIBLE BASE	54.00	40000.	0.35	14.00	18.00	75.00
3	C	STABILIZED SUBGR	15.00	20000.	0.30	8.00	8.00	90.00
4	D	SUBGRADE(200)	2.00	8000.	0.40	200.00	200.00	90.00

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

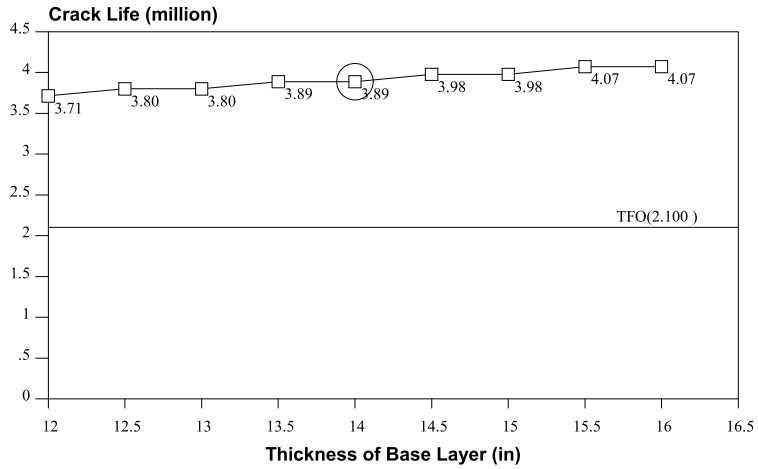
PROB	DIST.-14	COUNTY-227	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
1	**Austin**	**TRAVIS**	**0123**	**4**	**567**	**2**	**4/5/2024**	**3**

C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST
1

MATERIAL ARRANGEMENT	ABC
INIT. CONST. COST	47.25
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.00
SALVAGE VALUE	-6.62
TOTAL COST	40.63
NUMBER OF LAYERS	3
LAYER DEPTH (INCHES)	
D(1)	5.50
D(2)	14.00
D(3)	8.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	21.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 9

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	5.50	650.00	0.35	ASPH CONC PVMT
Base	14.00	40.00	0.35	FLEXIBLE BASE
Subbase	8.00	20.00	0.30	STABILIZED SUBGR
Subgrade	200.00	8.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

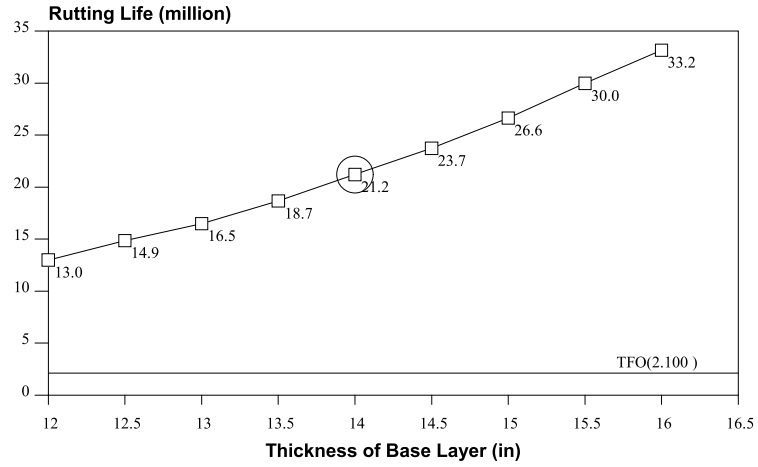
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477



TFO(Traffic to 1st Overlay): 2.10 (million)

Crack Life: 3.89 (million) ε_τ = 143.00 (με)

Rut Life: 21.20 (million) ε_v = -242.00 (με)

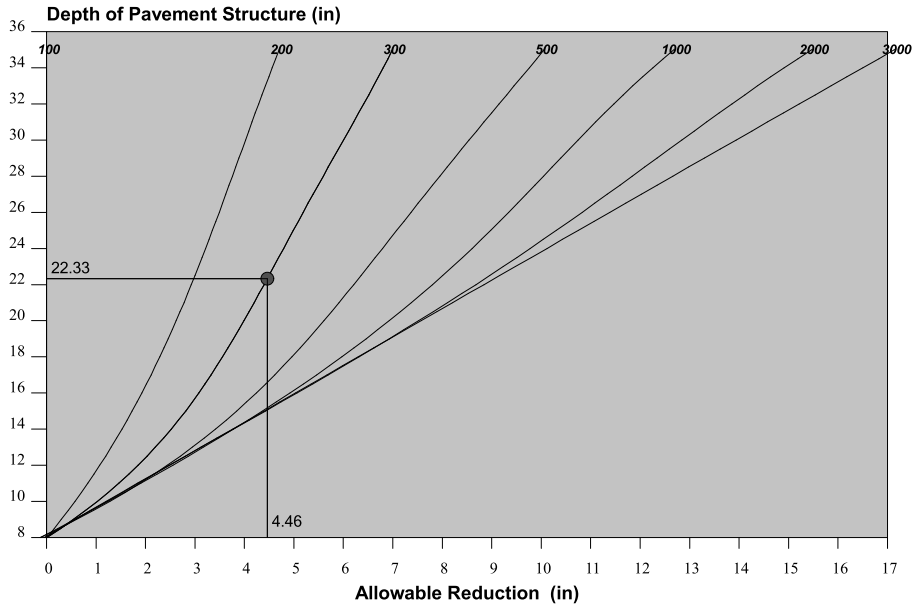
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.10millions.
Also the start ADT:5000.0 and ending ADT:10950.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	5.50	650.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	14.00	40.00	0.35	FLEXIBLE BASE
STABILIZED SUBGR	8.00	20.00	0.30	STABILIZED SUBGR
SUBGRADE(200)	200.00	8.00	0.40	SUBGRADE(200)
Bed Rock		800.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	10000.0 (lb)
Percentage of TandemAxles	49.0 (%)
Modified Cohesionmeter Value	300.0
Design Wheel Load	10000.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.80

TTC is based on Texas County Soil Database for (TRAVIS)

For soils type : clay of high plasticity, fat clay(CH)

RESULT:

Triaxial Thickness Required	22.3 (in)
The FPS Design Thickness	27.5 (in)
Allowable Thickness Reduction	4.5 (in)
Modified Triaxial Thickness	17.9 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	2	Problem	1
C-S-J	0123 - 4 - 567	Date	4/5/2024
District	Austin	County	TRAVIS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

Brad J. Carabajal PE

From: Nikki Conley <nconley@gbateam.com>
Sent: Thursday, May 2, 2024 3:28 PM
To: Brad J. Carabajal PE
Cc: John A. Alvarez II; 'Scott Dunlop'; Pauline Gray; Lance Zeplin; Matthew Woodard
Subject: RE: Newhaven - Pavement Section Comments

Brad,
After reviewing the Supplemental Pavement recommendations report for Newhaven Subdivision, the City is receptive to these updates to your proposed option 2 for each street type based on Manor's historical pavement performance:

- Use Geogrid for both street types
- Meet or exceed a treated subgrade thickness of at least 16"
- Consider cement stabilized treated subgrade

For this requested exception to the City criteria, the HMAC surface, HMAC base, and flex base thickness shown are acceptable in option 2 for each street type; however, the City has experienced better performance with deeper depths of treated subgrade, therefore, 16" is noted above.

GBA

Nikki Conley PE (MO,KS,TX, IL) Senior Engineer
16305 Swingley Ridge Road, Ste 300 | Chesterfield, Missouri
9601 Amberglen Boulevard, Ste 109 | Austin, Texas
d 737.247.7536

From: Brad J. Carabajal PE <bcarabajal@quiddity.com>
Sent: Tuesday, April 23, 2024 8:37 AM
To: Nikki Conley <nconley@gbateam.com>; Pauline Gray <pgray@gbateam.com>
Cc: John A. Alvarez II <jalvarez@quiddity.com>; 'Scott Dunlop' <sdunlop@manortx.gov>
Subject: RE: Newhaven - Pavement Section Comments

Good morning Nikki,

I wanted to follow up on this review.

Thanks,

Brad Carabajal, P.E.
Project Engineer
Email: bcarabajal@quiddity.com
T: 512-685-5117

From: Nikki Conley <nconley@gbateam.com>
Sent: Wednesday, April 17, 2024 5:33 PM
To: Brad J. Carabajal PE <bcarabajal@quiddity.com>; Pauline Gray <pgray@gbateam.com>
Cc: John A. Alvarez II <jalvarez@quiddity.com>; 'Scott Dunlop' <sdunlop@manortx.gov>
Subject: RE: Newhaven - Pavement Section Comments

Brad,
Thank you this is under review.

Nikki Conley PE (MO, KS, TX, IL) Senior Engineer
d 737.247.7536

From: Brad J. Carabajal PE <bcarabajal@quiddity.com>
Sent: Wednesday, April 17, 2024 3:01 PM
To: Nikki Conley <nconley@gbateam.com>; Pauline Gray <pgray@gbateam.com>
Cc: John A. Alvarez II <jalvarez@quiddity.com>; 'Scott Dunlop' <sdunlop@manortx.gov>
Subject: RE: Newhaven - Pavement Section Comments

Good afternoon Nikki and Pauline,

I wanted to follow up on this. Have you been able to review the updated proposal from Raba Kistner?

Thanks,

Brad Carabajal, P.E.
Project Engineer
Email: bcarabajal@quiddity.com
T: 512-685-5117

From: Brad J. Carabajal PE
Sent: Tuesday, April 16, 2024 8:02 AM
To: Nikki Conley <nconley@gbateam.com>; Pauline Gray <pgray@gbateam.com>
Cc: John A. Alvarez II <jalvarez@quiddity.com>; Scott Dunlop <sdunlop@manortx.gov>
Subject: Newhaven - Pavement Section Comments

Good morning Nikki and Pauline,

See attached for the updated letter from Raba Kistner. They added a pro and con section. Option 2 has been provided as a section representing RK standard practice. We would like to get this variance on next month's PNZ agenda if possible.

Thanks,

Brad Carabajal, P.E.
Project Engineer

QUIDDITY

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www.quiddity.com

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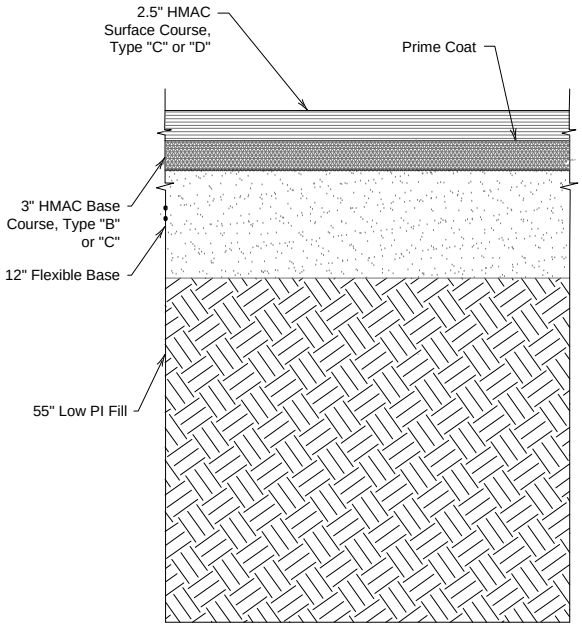
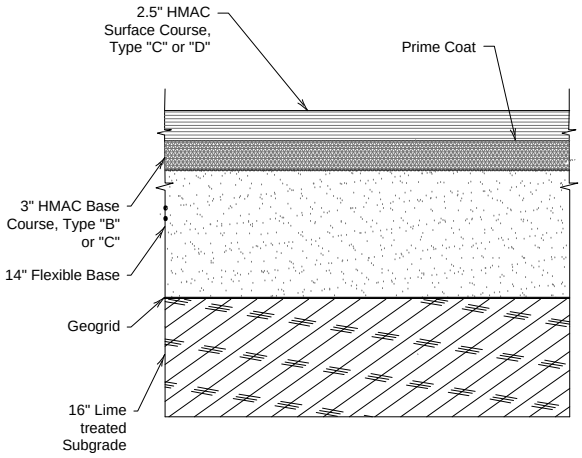
K:\16759\16759-0007-02 Newhaven Subdivision\2 Design Phase\CAD\Subdivision Construction Plan\16759-0007-02 DETAILS-MISC.dwg

COLLECTOR

POTENTIAL CODE REQUIRED SECTION



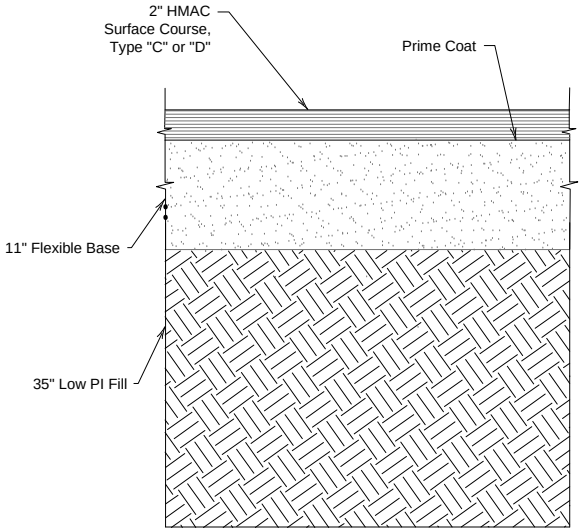
APPROVED ALTERNATIVE



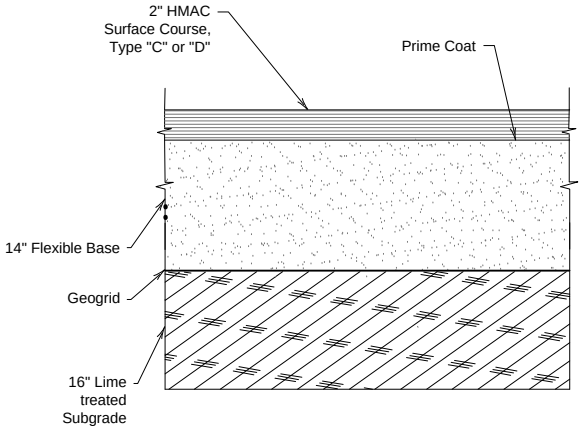
REFER TO GEOTECHNICAL REPORT BY RABA KISTNER, "*Supplemental Pavement Revision No. 3 - Emailed 04-15-2024*" PROJECT NUMBER *AAA23-130-00*, DATED April 15, 2024 FOR MORE DETAILS.

RESIDENTIAL

POTENTIAL CODE REQUIRED SECTION



APPROVED ALTERNATIVE



NEWHAVEN

PAVEMENT VARIANCE EXHIBIT

QUIDDITY
Texas Board of Professional Engineers and Land Surveyors Registration Nos. F-23290 & 10046100
3100 Alvin Devane Boulevard, Suite 150 Austin, Texas 78741 512.441.9493

SCALE:	NTS
DATE:	05/15/2024
JOB NO:	16759-0007-02