City of Corpus Christi

Infrastructure Design Manual

Chapter 6

STREET DESIGN REQUIREMENTS

Updated September 30, 2022

Chapter 6

STREET DESIGN REQUIREMENTS

6.1 ROADWAY DESIGN STANDARDS

a. All streets shall, at a minimum, be designed and installed in accordance with the Urban Transportation Plan (UTP) Guidelines, Comprehensive Plan, applicable area development, ~~and~~ master plans, the approved Mobility Plan, and the Design Standards.

b. Streets shall be designed for a 30-year life in accordance with the American Association of State Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures ("the AASHTO Design Guide") 1993 Edition and supplements unless a later edition of the AASHTO Design Guide is required by the Design Standards under the latest edition of the Infrastructure Design Manual and supplements. (Ordinance 030023, 12/10/2013)

c. In the event of any conflicts between the Design Standards and any edition or supplement to the AASHTO Design Guide, the Design Standards prevail.

d. Any variations or deviations to the Street Design requirements/standards shall be **approved by Director of Public Works**

6.2 ROADWAY GEOMETRIC DESIGN STANDARDS

6.2.1 Street Classifications and Street Design Standards per UTP Guidelines

a. Designers shall adhere to the Urban Transportation Plan Guidelines as shown in the UTP and the roadway geometric design criteria are shown in the table below.

b. Roadway geometric design shall follow AASHTO and NACTO guidelines and the UDC.

c. Urban Streets are classified as below:

1. Local streets (L-1A, L-1B)
2. Non-Local Streets
    - I. Minor residential collector (C1)
    - II. Secondary collector (C2)
    - III. Primary collector (C3)
    - IV. Parkway collector (P1)

V. Minor arterial (A1)

VI. Secondary arterial (A2)

VII. Primary arterial (A3)

VIII. Freeways (FR)

d. All urban streets within the City and ETJ shall be designed with curb and gutter, underground utilities and storm drainage systems to the appropriate design year storm as indicated in Chapter 3 unless otherwise approved by the City Engineer Development Services Engineer.

e. Rural Streets are classified as below:

i. Local rural streets (LRS)

ii. Minor rural arterial (RA1)

iii. Secondary rural arterial (RA2)

iv. Primary rural arterial (RA3)

f. Rural streets may be designed with above ground storm drainage systems to the appropriate design year storm as indicated in Chapter 3.

g. Center medians shall be designed with a minimum of 16-feet to accommodate shelter for dedicated left turn lanes.

6.2.2. Street Right-of-Way Dimensional Standards

Street right-of-way dimensional standards for different street classification shall be as shown in the table.

Table 6.2.2.A Local Street Standards

Local Street Section Type	Right of Way Width	Planting/ Utility Area	Street Section Width (BC)	Bump-Out *	Tied Sidewalk	Sidewalk Required Both sides	Traffic Lanes	Parking Sides Allowed	Max Trips/Day and Max Length	Cul-de-sac and Max Length
L-1A	50 ft	6 ft	28 ft	With= 6 ft Without = 0 ft	Not Allowed	Yes **	2-way	Two	1,600 trips/ day- NTE 2,640 ft	Yes (800’)
L-1B	50 ft	7 ft	28 ft	6 ft	Required	Yes **	2-way	Two	1,600 trips/ day- NTE 2,640 ft	Yes (800’)
~~**L-1C**~~	~~46 ft~~	~~7 ft~~	~~28 ft~~	~~With= 6 ft Without = 0 ft~~	~~Not Allowed~~	~~No~~	~~2-way~~	~~Two~~	~~1,600 trips/ day- NTE 2,640 ft~~	~~Yes (800’)~~
~~**L-1D**~~	~~46 ft~~	~~7 ft~~	~~28 ft~~	~~6 ft~~	~~Required~~	~~No~~	~~2-way~~	~~Two~~	~~1,600 trips/ day- NTE 2,640 ft~~	~~Yes (800’)~~
~~**L-1E**~~	~~40 ft~~	~~7 ft~~	~~22 ft~~	~~With= 6 ft Without = 0 ft~~	~~Not Allowed~~	~~No~~	~~1-way~~	~~One~~	~~800 trips/ day- NTE 1,320 ft~~	~~No~~
~~**L-1F**~~	~~40 ft~~	~~7 ft~~	~~22 ft~~	~~6 ft~~	~~Required~~	~~No~~	~~1-way~~	~~One~~	~~800 trips/ day- NTE 1,320 ft~~	~~No~~

1) Design Speed for local street is 25 miles per hour (MPH)
2) Sidewalk width for local streets is 4 ft.
3) The thru lane is one
4) *Bump-Out spacing parallel to curb: Minimum 150 feet, Maximum 300 feet
5) **Sidewalks not required on Residential Estate Zoning District, unless required for ADA compliance.

Table 6.2.2.B Non-Local Street Standards Table

Non-local Streets*	ROW Width (ft.)	BB Width (ft.)	Through Lanes	Median/ Turn Lane	Spacing (miles)	Sidewalk** (ft.)	Back of Curb to Property Line (ft.)	Avg. Daily Trips
Minor Residential Collector (C1)	60	40	2	No	0.25 to 0.5	5	10	4,000 - 8,000
Secondary Collector (C2)	65	41	3	Center turn	0.25 to 0.5	5	12	8,000 - 10,000
Primary Collector (C3)	75	50	4	No	0.25 to 0.5	5	12.5	10,000 – 14,000
Parkway Collector (P1)	80	40	2	--	0.25 to 0.5	5 to 8	14.5 to 25.5	4,000 – 8,000
Minor Arterial (A1)	95	64	4	Center turn	1.0 to 1.5	5	15.5	15,000 - 24,000
Secondary Arterial (A2)	100	54	4	Median	1.0 to 1.5	5	15	20,000 – 32,000
Primary Arterial (A3)	130	79	6	Median	1.0 to 1.5	5	17.5	30,000 – 48,000
Freeway (FR)	400	Varies	--	Median	--	No	19	60,000 – 200,000

(Ordinance 030769, 02/16/2016)

1. *Non-local streets contain curb, gutter and underground drainage.
2. Sidewalk width for non-local streets is 5 ft.
3. ~~**Sidewalks are not required in industrial areas.~~

Table 6.2.2.C Rural Street Standards Table

	ROW Width (ft.)	Pavement Width (ft.)	Lanes	V-Ditch or Left Turn	Bikeway Capable	Sidewalk*	Roadside Ditch Width
Local rural Streets (LRS)	60	26	2	--	No	No	34
Minor Rural Arterial (RA1)	125	44	2	--	No	No	40.5
Secondary Rural (RA2)	150	82	4	Center turn	No shoulder	No	41.5
Primary Rural Arterial (RA3)	250	76	4	Median v-ditch	No shoulder	No	48

(Ordinance 030769, 02/16/2016)

~~1. **Sidewalks are not required in industrial areas.~~

Table 6.2.2.D Geometric Design Criteria

Design Element Width	Preferred (Feet)	Minimum (Feet)
Travel Lanes	11	10
Turn Lanes	12	10
Median Width at Turn Lanes	17	15
Median Width Face of Curb to Face Of Curb	17	4
Center Turn Lane Width	12	10
Standard Bike Lane	7	6
Buffered Bike Lane	10	8
Buffered Sidewalk	5	5
Tied-Sidewalk	5	5
Multi-Use Side Path	10	8
Shared Use Path/Hike N Bike Trail	14	12
One-Way Cycle Track, Both Sides	6	6
Landscape/Parking Buffer	5	2

6.2.3 Pedestrian Accommodations

a. Sidewalks shall be per the Street Classifications and Street Design Standards

b. Curb Ramps shall be to the Texas Accessibility Standards (TAS)

c. Driveways shall have the appropriate cross slope per TAS

d. Medians shall be designed with pedestrian shelter where appropriate

e. Bus Stops shall be designed to RTA standards such that they do not encroach into the required sidewalk passage area per TAS

6.2.4 Curb Radii

a. The curb radius is the radius of curvature, measured from the center of curvature, of a physical curb-return at the corner of a street intersection.

b. In selection of curb radii, the designer shall consider the needs of all roadway and pedestrian traffic and use appropriate representative design vehicle templates.

c. Curb radii around cul-du-sacs shall be as follows:

   i. Single-Family Residential = 48-ft.

   ii. All other areas = 50-ft.

d. Other curb radii shall be as in Table ~~6.3~~ below:

Table 6.2.4.A Standard Curb Radius by Intersection Type and Angle

Intersection Type			Standard Curb Radius by Intersection Angle	
			90°	**80° TO 90°**
Local	to	Local	15-FT.	15-FT.
Local	to	Collector	20-FT.	20-FT.
Local	to	Arterial	20-FT.	20-FT.
Collector	to	Collector	25-FT.	25-FT.
Collector	to	Arterial	25-FT.	25-FT.
Arterial	to	Arterial	30-FT.	35-FT.
Industrial Zone			45-FT.	50-FT.

6.2.5 Curb and Gutter

a. Curb and Gutter shall be considered a stormwater appurtenance for estimating cost

b. For most roadways, a 6-in. curb is required.

c. For hot-mixed asphaltic concrete roadways, a 2-ft. wide Portland cement concrete curb and gutter is required, to include 6-inches of curb width and 1 ½-feet of gutter width.

d. For Portland cement concrete pavement, the gutter area is integral with the pavement panel, and the 6-inch curb is placed on top of the pavement panel per City Standard Details.

6.2.6 Objects in the R.O.W.

a. Above ground infrastructure such as fire hydrants, trees, traffic signal controller cabinets, blow-off valves, power poles, light poles, traffic/pedestrian signage, or other such appurtenances shall not be placed within the sidewalk, or otherwise encroach on ADA/TAS pedestrian space or RTA bus stops and pads.

b. Designers shall coordinate with the RTA in regard to placement and design of benches, pads, turnouts, and bus stop locations. Bus stops can only be placed, moved, or removed with RTA concurrence.

6.2.7 Design Speed

a. Design speed shall be set by City Ordinance

b. The minimum design speed shall be 25 m.p.h.

6.2.8 Sight Distance

a. **Intersection Sight Distance**

   i. Approach and Departure Sight Triangles shall be Per American Association of State Highway and Transportation Officials (AASHTO) *Green Book* and National Association of City Transportation Officials (NACTO) *Urban Street Design Guide* latest editions.

   ii. Designers, Engineers, and Constructors shall not obstruct sight triangles.

   iii. The design vehicle for sight distance is a passenger car.

iv. Easement dedications shall be required as needed to accommodate appropriate sight triangles.

v. Designers, Engineers, and Constructors shall utilize decision points derived from sight triangles combined with stopping sight distance when designing intersection treatments and advance warning signs, signals, striping, and devices.

b. **Stopping Sight Distance**

i. Stopping Sight Distance per the AASHTO Green Book and TxDOT/FHWA Texas MUTCD.

c. Passing Sight Distance

i. Passing Sight Distance per AASHTO and TxDOT/FHWA where applicable.

Table 6.2.8.A Minimum Required Stopping Sight Distances for Dry Conditions

Vehicle Speed	Reaction Distance	Breaking Distance	Summed Distance	Stopping Sight Distance
(mph)	(feet)	(feet)	(feet)	(feet)
15	55.1	21.6	76.7	80
20	73.5	38.4	111.9	115
25	91.9	60.0	151.9	155
30	110.3	86.0	196.7	200
35	128.6	117.6	246.2	250
40	147.0	153.6	300.6	305
45	165.4	194.4	359.8	360
50	183.8	240.0	423.8	425
55	202.1	290.3	492.4	495

6.2.9 Left Turn Lanes

a. Left turn lanes are required at all signalized intersection approaches

b. Left turn lanes are required at all median openings

c. Queueing capacity shall be determined by appropriate traffic studies and 30-year projections and accommodated in the design of the queue lane.

d. Dual left turn lanes shall be approved only after an appropriate traffic study that includes alternatives assessment to handle the anticipated volumes.

6.2.10 Intersection Standards

a. Through-lane offsets from entering lane to receiving lane shall not exceed 3-feet.

b. Roundabout intersections shall be considered for any intersection with an appropriate traffic study considering traffic volumes and directions, as well as alternative treatments such as all-way stops and traffic signalization, to include 30-year projections and appropriate design vehicles in the approach roadways to ensure required roundabout radius.

    i. All roundabouts will feature splitter islands with pedestrian shelter upon entry, appropriate signage, appropriate lighting, appropriate pedestrian elements, and a truck curb and mow strip in the central island.

    ii. Central island art or landscaping shall not obstruct safe site zones or be a hazard to vehicles that may leave the roadway.

6.2.11 Horizontal Curve Radii

a. Curve Radii design shall be based on the design speed of the roadway and any super-elevation that may be part of the design.

b. Minimum curve radii for collectors and arterials is 500 feet.

c. Minimum curve radii for local streets is 300 feet per AASHTO Table 3-13b Minimum Radii and Superelevation for Low-Speed Urban Streets.

d. Maximum super-elevation will be 4%

e. Reverse super-elevation shall not be allowed on any City roadways

6.2.12 Vertical Geometric Requirements

a. Minimum grade line shall be 0.3%

b. Grades for curb returns shall be determined on a case-by-case basis.

c. Arterials shall feature super-elevation per AASHTO requirements

d. Vertical curves

    i. shall be designed and constructed when the algebraic difference exceeds 1%

    ii. elevations shall be shown at 10-foot intervals in plans

    iii. maintain a minimum of 0.03-foot elevation change at 10-foot intervals

    iv. determine minimum vertical curve lengths based on AASHTO design criteria with minimum not less than 3 times design speed.

e. Minimum grade line around a cul-du-sac shall be 0.70 percent

f. Pavement cross-slopes shall be

    i. Minimum 2%

    ii. Maximum 4%

6.3 <u>PAVEMENT DESIGN AND CONSTRUCTION STANDARDS</u>

6.3.1 Pavement Structure.

a. Through The design of pavement structures shall be in accordance with the AASHTO *Guide for Design of Pavement Structures*, 1993 or latest approved edition.

b. The pavement design report shall be prepared and signed by, or under the supervision of, a professional engineer registered in the State of Texas.

c. The minimum design requirements as outlined herein shall be used for pavement design.

6.3.2 Length of Service Life.

a. Pavement shall be designed with a **thirty-year** service life.

6.3.3 Traffic Load, Reliability and Pavement Structures.

a. The traffic load is the cumulative expected 18-Kip equivalent single axle loads (ESAL) for the service life.

b. The following 18-Kip ESAL and Reliability Level shall be used in the design of streets for each street classification.

~~Table 6.5. Pavement Design Specifications~~

~~Street Classification~~	~~18-Kip ESAL*~~	~~Reliability Level~~
~~Primary and Secondary Arterials~~	~~5,000,000~~	~~R-95~~
~~Collector Streets~~	~~2,000,000~~	~~R-90~~
~~Local (non-residential) traffic~~	~~1,000,000~~	~~R-80~~
~~Local (residential collector) traffic~~	~~100,000~~	~~R-75~~
~~Local (residential) traffic~~	~~50,000~~	~~R-70~~

Table 6.3.3A Pavement Design Specifications

Street Classification	ADT Lower Limit	ADT Upper Limit	18-Kip ESAL*	Reliability Level
Primary Arterial (A3)	30,000	48,000	6,000,000	R-95
Secondary Arterial (A2)	20,000	32,000	4,000,000	R-95
Minor Arterial (A1)	15,000	24,000	3,500,000	R-95
Primary Collector (C3)	10,000	14,000	2,600,000	R-90
Secondary Collector (C2)	8,000	10,000	2,000,000	R-90
Minor Residential Collector (C1) and Parkway Collector (P1)	4,000	8,000	1,200,000	R-80
Local Residential - Section L-1 (A-B)	-	-	50,000	R-70

*This is the minimum 18-KIP ESAL value. For all arterials, collectors and non-residential local streets (based on zoning) the engineer shall evaluate the existing ADT and traffic type distribution and use the greater of the 30-year projection of the field verified ESAL or the ESAL value established in this Table. ~~For City of Corpus Christi projects, the Traffic Engineer will provide a traffic count for design purposes.~~

c. The Traffic loads for primary and secondary arterials, collector and local residential collector streets shall include bus traffic.

d. The lane distribution factor shall be as follows:

i. Total number of lanes in both directions 4 (2 in each direction) or less, the Lane Distribution Factor is 1.0.

ii. Total number of lanes in both directions 6 (3 in each direction), then lane Distribution Factor is 0.7

iii. Total number of lanes in both directions less than 8 (4 in each direction), then Lane Distribution Factor is 0.6

~~6.3.4 Input Design Values:~~

~~a. Serviceability~~

~~i. The serviceability of a pavement is defined as the pavement's ride quality and its ability to serve the type of traffic (automobiles and trucks) which use the facility.~~

~~ii. The initial serviceability index (p0) for flexible pavements shall be 4.2 and for rigid pavement shall be 4.5.~~

~~iii. The minimum terminal serviceability index (Pt) for flexible pavements shall be:~~

~~1. Local streets shall be 2.0~~

~~2. Collectors and arterials shall be 2.5~~

~~3. For rigid pavements the Pt shall be 2.5 for all streets~~

~~4. A standard deviation (S0) for flexible pavement shall be 0.45 and for rigid pavement shall be 0.39.~~

~~b. 28-day Concrete Modulus of Rupture (Mr)~~

~~i. An Mr of 680 psi at 28 days should be used with the current statewide specification for concrete pavement design.~~

~~ii. If the engineer selects an alternate value for Mr, it must be documented with an explanation.~~

~~c. 28-day Concrete Elastic Modulus (psi)~~

~~i. A modulus of 5,000,000 psi should be used for pavement design.~~

~~ii. The use of a different value must be documented with an explanation.~~

d. Effective Modulus of Subgrade Reaction (pci)

i. For Arterials and Collector Streets one of the following base layer combinations for concrete slab support shall be used

1. 4in. of asphaltic concrete pavement (ACP) or asphalt stabilized base (ASB)

2. A minimum of 1 in. asphalt concrete bound breaker over 6 in. of a cement stabilized base or crushed limestone base material.

3. A k-value of 300 psi/in. should be used in the rigid pavement design procedure with one of the stabilized base layer combinations listed above.

4. For all local streets on clay subgrade soils with 8-inches of lime stabilized subgrade a k-value of 110 pci shall be used and for local streets on sand subgrade a k-value of 200 pci shall be used.

Table 6.6. Load Transfer Coefficient

Load Transfer Coefficients		
CRCP or Load Transfer Devices at Transverse Joints	**Tied PCC Shoulders, Curb and Gutter, or Greater than Two Lanes in One Direction**	
	Yes	**No**
Yes	2.6 for CRCP 2.9 for JCP	3.2
No	3.7	4.2

e. **Drainage Coefficient**

i. 1.0 for heavy clay (Type A) soils and 1.05 for sand (Type B) soils. If the sands will be subject to tidal influence or saturation then a lower coefficient is warranted.

6.3.5 Rigid Pavement Thickness

a. The computed concrete slab thickness usually contains fractions of inches, round the thickness up or down to the nearest full or half inch. For example, use slab thickness of 11.5in. for computed thickness of 11.4 in. and use slab thickness of 10 in. for computed thickness 10.24 in. Use 6 in, for slab thickness if the computed thickness is less than 6 in., i.e., minimum rigid pavement thickness is 6 in.

6.3.6 Subgrade Soil

a. A soil investigation must be performed for the design of pavement structures.

b. The number of borings and locations shall be sufficient to accurately determine the natural in-situ soil strata and the thickness of the existing pavement constituents along the route.

c. Any existing soil information that is available either from the City or private sources will be evaluated and if determined to be applicable and valid, will be allowed in place of new soil tests.

6.3.7 Pavement Structural Section

a. Roadbed soil having a plasticity index (P.I.) greater than 20 shall be treated with lime to reduce the P.I. below 20.

b. The following test method shall be used to determine the percent lime to be used:

   i. pH Determination for Minimum Lime Content: ASTM D 6276 (Eads - Grim Test) - Min amount of lime to raise soil pH level to 12.4.

   ii. For design of the stabilized subgrade TxDOT Test Method 121-E Figure 3 "RECOMMENDED AMOUNTS OF LIME FOR STABILIZATION OF SUBGRADES AND BASES" shall be used.

   iii. Application rate of lime shall be determined based on laboratory testing.

   iv. In no case shall the lime be less than 8%.

   v. Percent lime will be based on the maximum dry unit weight of the raw subgrade soils as determined by the standard proctor (ASTM D698).

   vi. Lime treated subgrade will be included as a structural layer within the pavement design calculations.

   vii. The use of a City-approved geogrid is an acceptable option in lieu of up to 8 inches of lime-modified subgrade only for Type A soils with a pre-modified PI < 20 and with prior approval of the City Engineer.

   viii. Considerations for using geogrid in place of lime-modification include speed of construction, same day restoration of access to driveways, protection from plastic deformation or loss of soil strength in soil layers below the improved zones, and other considerations.

   ix. City-approved geogrid includes any geogrid classified as Type 2 geogrid by TxDOT under the most current version of TxDOT Departmental Materials Specification DMS-6240 per City Standard Specification Section 022040 *Street Excavation*.

x. ~~The layer coefficient ratio (LCR) for pavement design with geogrid shall not exceed 1.2.~~

xi. ~~Alternate pavement design must be approved by the City of Corpus Christi, Director of Public Works.~~

c. ~~Cement Stabilized Sand~~

i. ~~(P.I. < 20) for stabilization of utility trenches~~

ii. ~~shall contain a minimum of 2 sacks of Standard Type I Portland cement per cubic yard of sand and compacted to not less than 95% Standard Proctor density per City Standard Specification Section 022020 *Excavation and Backfill for Utilities*.~~

d. ~~Pavement Materials~~

i. ~~Alternative pavement materials may be used where the existing soil or subsurface conditions, or the alternative materials, provide a level of drivability comparable to the materials otherwise required by this section.~~

ii. ~~Proposals for alternative pavement materials with supporting engineering documentation may be submitted to the City for consideration for use. Alternative materials will not be allowed unless otherwise approved by the Director of Engineering.~~

iii. ~~The combination of materials will be allowed for the various layers of the pavement structure as shown in below table.~~

e. ~~Private Development Pavement~~

i. ~~The Director of Development Services in consultation with the Director of Engineering Services in accordance with the standards provided herein must approve the pavement combination for private development.~~

f. ~~Public Roadway Pavement~~

i. ~~The Director of Engineering must approve the pavement combination for public work.~~

ii. ~~The detailed material specifications of these materials are outlined in the City of Corpus Christi Standard Specifications and Details.~~

g. ~~Minimum Layer Thickness (Compacted)~~

i. ~~If the following components are utilized in proposed pavement sections, the minimum thickness for the components shall be as shown in Table below:~~

h. ~~Curb and Gutter:~~

i. ~~Curb and gutter shall be installed as shown on the City Standard Details~~

~~and as required in the appropriate road section. Both the lime-treated subgrade and flexible base shall extend 1 foot beyond the back of curb. Transitions between the curb and gutter sections to either existing curb and gutter sections or roadside ditches shall be detailed in such a way as to ensure positive drainage to the nearest drainage system.~~

~~i. Cross-slopes~~

~~i. The road section cross-slope from the crown to the gutter shall be a consistent 2% minimum~~

~~ii. the maximum acceptable cross-slope on new construction or full depth reconstruction is 4%.~~

~~iii. Crown to crown transitions are required at intersections and neither concrete or asphalt valley gutters are allowed.~~

~~j. **Minimum Pavement Section for Residential Streets**~~

~~i. In the event that the developer would prefer to install a pavement section on a residential road without design, the structural section as outlined in the following tables shall be used.~~

~~ii. These sections were developed to meet the 30-year design life as required by Section 8.2 of the UDC. In general, the Type A soils (clays) are found throughout Corpus Christi with the exception of North Beach, Flour Bluff, and North Padre Island, which instead primarily have Type B soils (sands).~~

Table 6.3.7.A Pavement Materials by Pavement Type and Layer

Type	Layer	Material/Treatment		Standard or Specification
All	Subgrade Stabilization	Density Controlled	95% Standard Proctor Density	ASTM D698
		Moisture Controlled	+/- 3% of optimum moisture content	
		Lime Stabilization	Type A (clay) Soils only	TxDOT 260 Tex 121-E
		Cement Stabilization	Type B (sandy) Soils only	TxDOT 275
		Lime Modification w/Cement Stabilization	Type A (clay) Soils only if PI<20	
	Flexible Base	Only TxDOT Type A, Grade 1-2 crushed limestone base allowed on City roadway projects without pre-approval.		
		Density Controlled	98% Modified Proctor Density	ASTM D1558
		Moisture Controlled	+/- 2% of optimum moisture content	
		Cement Stabilization	Optional	TxDOT 275
		Geogrid	Only when pre-modified subgrade 10<PI<20	TxDOT DMS-6240 City of CC Section 022040
Flexible	Seal Coat	One-Course Surface Treatment		TxDOT 306/316
	Prime Coat	MC-30		TxDOT 310
	HMACP Base Course	Type B	2.5-in. (min.)	TxDOT 300/334
	Tack Coat			-
	HMACP Surface Course	Type D	1.5-in. (min)	TxDOT 300/334
Rigid	HMACP Bond Breaker	Type D	1.0-in. (min)	TxDOT 300/334
	Portland Cement	Reinforcement	Continuously Reinforced	TxDOT 360

	Concrete Pavemet		Jointed Reinforced	TxDOT 360

Table 6.3.7.B. Minimum Pavement Layer Thickness

Pavement Type	Roadway Type	Material & Type	Minimum Thickness	Additional Guidance
All	All	Flexible Base	6 in.	1 foot behind curb for urban roads and 2 feet beyond edge of pavement for rural roads
All	All	Asphalt Treated Base	4 in.	-
All	All	Lime-Treated Subgrade	8 in.	for stabilization or modification
HMACP	All	One-Course Surface Treatment	One Course	for all flexible base under HMACP
HMACP	All	Base Course (Type B)	2.5 in.	-
HMACP	All	Surface Course (Type D)	1.5 in.	-
HMACP	Left and Right Turn Lanes	Flexible Base	12 in.	-
HMACP		Asphalt Paving Surface Course (Type D)	4 in.	-
PCCP	All	Bond Breaker (Type D)	1 in.	per geotech report
PCCP	All	Portland Cement Concrete Pavement	6 in.	-

~~Table 6.3.7.C. Minimum Residential Structural Section on Type A (clay) Soils using HMACP~~

~~Structural Material~~	~~Section L-1 (A-B)~~	~~Minor Residential Collector~~	~~Collector~~
~~HMAC Pavement (Type D)~~	~~2"~~	~~2"~~	~~4"~~
~~Flexible Base (Type A, Grade 1-2)~~	~~6"~~	~~8"~~	~~11"~~
~~Subgrade~~	~~8" Lime Stabilized~~	~~8" Lime Stabilized~~	~~8" Lime Stabilized~~

~~Table 6.3.7.D. Minimum Residential Structural Sections on Type A (clay) Soils using PCCP~~

~~Structural Material~~	~~Section L-1 (A-B)~~	~~Minor Residential Collector~~	~~C-1 Collector~~	~~Section L-1 (A-B)~~	~~Minor Residential Collector~~	~~C-1 Collector~~
~~Concrete (4,400 psi min)~~	~~6"~~	~~6"~~	~~7"~~	~~6"~~	~~6"~~	~~6"~~
~~HMAC Bond Breaker (Type D)~~	~~1"~~	~~1"~~	~~1"~~	~~1"~~	~~1"~~	~~1"~~
~~Flexible Base (Type A, Grade 1-2)~~	~~6"~~	~~6"~~	~~6"~~	~~6"~~	~~6"~~	~~6"~~
~~Subgrade~~	~~8" Lime Stabilized~~	~~8" Lime Stabilized~~	~~8" Lime Stabilized~~	~~12" Compacted~~	~~12" Compacted~~	~~12" Compacted~~

~~Table 6.3.7.E. Minimum Residential Structural Sections on Type B (sandy) Soils using HMACP~~

~~Structural Material~~	~~Section L-1 (A-B)~~	~~Minor Residential Collector~~	~~C-1 Collector~~
~~HMAC Pavement (Type D)~~	~~2"~~	~~2"~~	~~3"~~
~~Flexible Base (Type A, Grade 1-2)~~	~~6"~~	~~6"~~	~~6"~~
~~Subgrade~~	~~8" Cement Stabilized~~	~~8" Cement Stabilized~~	~~10" Cement Stabilized~~

~~Table 6.3.7.F. Minimum Residential Structural Sections on Type B (sandy) Soils using PCCP~~

~~Structural Material~~	~~Section L-1 (A-B)~~	~~Minor Residential Collector~~	~~C-1 Collector~~
~~PCCP (4,400 psi min)~~	~~6"~~	~~6"~~	~~6"~~
~~HMACP Bond Breaker (Type D)~~	~~1"~~	~~1"~~	~~1"~~
~~Subgrade~~	~~8" Cement Stabilized~~	~~10" Cement Stabilized~~	~~12" Cement Stabilized~~

~~k. **Guidance for Designers, Engineers, Bidders, and Contractors:**~~

~~i. Roadway Designers and Geotechnical Engineers~~

~~Roadway designers and geotechnical engineers shall utilize a combination of subgrade treatments, road base, road base treatments, bond breaker, and HMACP or PCCP pavement to form the structural design section for City roadways. All layers in the section shall contribute to the structural strength of the pavement based on typical design practices. Some layers contribute to moisture control, such as lime-modified subgrade, bond breakers, and seal coats, while other layers~~

contribute to structural strength or structural stability in the section such as moisture-controlled/density-controlled subgrade, cement-treated subgrade, geogrid, lime-stabilized subgrade, moisture-controlled/density-controlled base, cement-treated base, and HMACP and PCCP. All layers should be working together to reduce or eliminate differential movements, deformations, and failures based on design guidance for level of service/reliability level for each roadway type in the City's Unified Development Code (UDC), UTP, and as shown in the IDM. For all types of paving, rigid paving or flexible paving, a stable platform for building the roadway must be achieved ahead of pavement construction. One key requirement to achieve a stable roadbed platform is the required use of cement-stabilized sand in utility trenches per City Standard Specification Section 022020 *Excavation and Backfill for Utilities* to prevent settlement and deformation of utility trenches under the roadway pavement.

For sandy soils, such as low PI Type B soils primarily in North Beach, Flour Bluff, and Padre and Mustang Islands, it is a requirement to cement stabilize the subgrade, which is a very fine sand, to avoid issues with localized collapses and deformations for both flexible and rigid pavements. Cement stabilization of roadway base may also be considered. Cement stabilization for a stable subgrade platform and a bond breaker for moisture control is required for rigid pavements in the Type B soil areas to reduce tilt and failure of pavement panels from subgrade material pumping or blowing out from between joints or cracks over time. Cement stabilization of Type A clay soils is not allowed unless the PI has been modified to below 10 and organics are less than 1%. In all cases of cement stabilization, whether for subgrade or base, microcracking must be employed ahead of applying the bond breaker/seal coat to prevent reflective cracking from moving up throughout the entire pavement profile to affect level of service or reliability at the pavement surface.

For clay soils, it is a requirement to add lime to keep the improved compacted subgrade layer from shrink/swell cycles or loss of soil strength and bearing capacity. The addition of lime is either to achieve lime modification to create a stable building platform or to achieve lime stabilization to reach a specified contribution to the pavement structural value. For lime modification of lower PI clay soils (PI < 20) for flexible pavements, geogrid can be considered to combat pavement deformations during loss of soil strength events such as supersaturation or complete loss of soil moisture through wet and dry meteorological cycles. Geogrid

~~structural strength contributions will be based on published strengths for the approved TxDOT Type 2 geogrids. Lime-modified subgrades (PI < 20) can also be stabilized with cement after a PI < 10 has been achieved. Lime-modified subgrade requires the contractor to work the lime into the specified subgrade layer rather than just proof-rolling, thereby providing a firm, dry, and stable platform on which to build up the pavement structure. In order for cement to be activated as a stabilizing agent, PI < 10 is required and organic material < 1%. Lime modification alone may be insufficient to prevent differential movement in extreme wet/dry events and the addition of geogrid or cement stabilization shall be considered to improve pavement performance and life for lime-modified subgrade. Geogrid can also replace up to 8 inches of lime-modified subgrade under certain circumstances and with prior approval of the City Engineer.~~

~~For higher PI clays (PI > 20), the addition of lime sufficient to achieve lime stabilization is required to minimize shrink/swell and the potential for loss of soil strength in the improved layer and to create a stable building platform. Lime stabilization is also required to achieve a specified soil strength in the pavement section to bridge over areas of varying soil strength in the soil layers below the improved zone, as well as to prevent supersaturation of the subgrade that would lead to loss of soil strength followed by rutting and pumping. Lime stabilization does not require the use of geogrid. Lime-only pavement sections with no geogrid layer shall be designed by the geotechnical engineer for all roadways. Lime-stabilized sections should be designed to achieve the specified soil strength within the improved layer and to achieve the calculated contribution to the overall pavement structural section. For lime-stabilized sections, geogrid is not required and shall not be substituted for lime stabilization. The minimum thickness for lime stabilized subgrade is 8-inches.~~

~~For the pavement design of a particular roadway segment, geotechnical engineers will provide a variety of pavement sections for use by the City and the design engineer during the pavement selection process. All geotechnical reports will include both flexible and rigid pavement section options for roadways unless specifically scoped otherwise. These pavement sections will include cement-stabilized subgrade in sandy areas, lime-stabilized subgrade in mid to high PI clay areas and lime-modified subgrade with or without geogrid in mid to low PI clay areas. The geotechnical engineer has the option of offering sections with cement-stabilized base in sandy or lime-modified clay areas. The geotechnical~~

~~engineer has the option of offering geogrid stabilized sections in lieu of lime-modified sections only when pre-treated PI < 20.~~

~~Geotechnical engineers will use a representative PI based on the mean of PI measurements plus ½ their standard deviation. For Example, a site with a mean PI of 20 and a standard deviation of 10 is assigned a representative PI of 25. Subgrade improvements will be for a minimum of 8-inches thickness for all roadways. Typical guidance on the application of subgrade treatments is as shown below in Table 6.11:~~

~~Table 6.3.7.G. Typical Pavement Structural Section per Plasticity Index (PI) for Flexible Pavements~~

~~Subgrade PI~~	~~Subgrade Treatment~~	~~Subgrade Replacement~~	~~Geogrid~~	~~Base Course~~	~~Seal Coat~~	~~Asphalt Base Course~~	~~Asphalt Surface Course~~
~~1 to 10~~	~~Cement Stabilized~~	~~None~~	~~None~~	~~Type A, Grade 1-2~~	~~1-course surface treatment~~	~~2.5-in HMAC Type B~~	~~1.5-in HMAC Type D~~
~~10 to 20~~	~~Lime Modified~~	~~Select Fill~~	~~Option~~	~~Type A, Grade 1-2~~	~~1-course surface treatment~~	~~2.5-in HMAC Type B~~	~~1.5-in HMAC Type D~~
~~20 to 75~~	~~Lime Stabilized~~	~~Select Fill~~	~~None~~	~~Type A, Grade 1-2~~	~~1-course surface treatment~~	~~2.5-in HMAC Type B~~	~~1.5-in HMAC Type D~~

~~ii.~~ ~~Bidders~~

~~Bidders are to bid per plan and specification. Bidders should seek to clarify any questions about alternate products or materials during the question-and-answer period. Bidders should not anticipate approval of alternate products or materials after award.~~

~~iii.~~ ~~Contractors~~

~~Contractors shall install the product specified or called in the plans unless a value-engineering proposal has been presented by the Contractor through the Change process outlined in Specification Section 00 72 00 *General Conditions* and accepted by the City Engineer as indicated by his signature on the change agreement. All credits back to the City must be accounted for in any value-engineering agreement per 00 72 00, to include contract time and labor.~~

~~The addition of geogrid to a lime-modified layer will be expected to add time and cost. For flexible pavement on low PI clays, the subtraction of lime modification and replacement by geogrid would be expected to subtract time and cost.~~

~~Consideration for the use of geogrid in lieu of lime can be made to expedite construction, protect commercial or residential property, or to quickly restore traffic as long as the in-situ subgrade PI is below 20 before lime modification.~~

~~Lime stabilization shall be executed according to TxDOT Specification Section 260 and TxDOT standard Tex 121-E.~~

~~Cement stabilization shall be executed according to TxDOT Specification Section 275.~~

~~Geogrid stabilization shall be provided according to TxDOT DMS-6240 and City Standard Specification Section 022040 - *Street Excavation*.~~

6.3.1 Input Design Values:

a. Pavement design input values include the current AASHTO Input Design Values for pavement calculations including Serviceability, Effective Modulus of Subgrade Reaction, k (pci), Concrete Pavement Load Transfer Coefficients, and Drainage Coefficients based on soil type. These input design values are outlined in the following tables:

Table 6.3.4A - Input Serviceability Values

	Serviceability	Flexible - Local Streets	Flexible - Collectors & Arterials	Rigid Concrete
Serviceability - *Ride quality & ability to serve the type of vehicles (automobiles & trucks) that use the facility*	**Initial Serviceability, (p0)**	4.2	4.2	4.5
	Min. Terminal Serviceability (Pt)	2.0	2.5	2.5
	Standard Deviation (S0)	0.45	0.45	0.39

Table 6.3.4B – Mr and Concrete Elastic Modulus Values for Concrete Pavement Design

28-Concrete Modulus of Rupture (Mr)	Mr = 680 psi at 28-days
28-day Concrete Elastic Modulus (psi)	5,000,000 psi

If the Engineer utilizes a different value of Mr, it must be documented with an explanation. The use of a different value for the Concrete Elastic Modulus should also be documented with an explanation.

Table 6.3.4C - Modulus of Subgrade Reaction, k (pci) for Concrete Pavement Design

Effective Modulus of Subgrade Reaction, k (pci)				**k Value (pci)**
Base Layer Combination for Concrete Pavement Support	Arterials & Collectors	*Option 1*	4" of asphaltic concrete pavement (ACP) or 4" asphalt stabilized base (ASB)	300
		Option 2	1" asphalt concrete bond breaker over min. 6" cement stabilized base or 1” asphalt concrete bond breaker over min. 8” compacted crushed limestone base	300
	Local Streets		Lime stabilized clay subgrade	110
	Local Streets		Lime/cement stabilized subgrade	240
	Local Streets		Sand subgrade	200
	Local Streets		Cement stabilized sand subgrade	240

Table 6.3.4D - Concrete Pavement Load Transfer Coefficients

Load Transfer Coefficient		
CRCP or Load Transfer Devices at Transverse Joints	**Tied PCC Shoulders, Curb & Gutter, or > 2 lanes in 1 Direction**	
	Yes	**No**
Yes	2.6 for CRCP, 2.9 for JCP	3.2
No	3.7	4.2

Table 6.3.4E - Drainage Coefficients

Drainage Coefficient	1.0 for clay Type A Soils
	1.05 for sand Type B Soils

6.3.2 Pavement Design Considerations

a. Other pavement design considerations include the criteria for the final design concrete pavement thickness based on the results of the AASHTO calculations, requirements of the geotechnical study, lime treatment and lime/cement treatment requirements for Type A clay soils, geogrid considerations, and the use of stabilized sand for utility trench stabilization are described in the Tables below.

Table 6.3.5A - Concrete Pavement Thickness Procedure

Concrete Pavement Thickness	The computed concrete slab thickness with fractions of inches round the thickness up or down to the nearest full or 1/2 inch. Minimum rigid pavement thickness is 6 inches.

Table 6.3.5B - Geotechnical Study Requirements

Geotechnical Study	A soil investigation **must be performed for the design of pavement** structures.
	The number of borings and locations shall be sufficient to accurately determine the natural in-situ soil strata and the thickness of the existing pavement constituents along the route. The maximum boring spacing should be 750 lf. Minimum boring depth shall be 10 feet in pavement areas, 20 feet for utility borings and 25 feet for traffic signal and light poles.
	Any existing soil information that is available either from the City or private sources will be provided as supplemental information for the new geotechnical study.

Table 6.3.5C - Lime Stabilized Subgrade and Lime/Cement Subgrade Requirements

In general, roadbed soil having a plasticity index (P.I.) greater than 20 shall be treated with lime or lime/cement to reduce the PI to below 20.	
The following test methods shall be used to determine the percent lime to be used:	
Subgrade - Lime Stabilization	pH determination for minimum lime content ASTM D 6276 - Eads-Grim Test. Minimum amount of lime to raise the pH to 12.4 or higher.
	Soil Lime Testing (Tex-121-E)
	Lime min. 8% all cases
Subgrade – Lime/Cement Stabilization	Sulfate testing should also be conducted before placement of lime to evaluate the potential for sulfate induced heave from the lime stabilization. Lime stabilization should be initially performed in general accordance with TxDOT Item 260. Once the minimum 24-hour mellowing period for lime is complete, the lime stabilized subgrade should be cement stabilized with cement per TxDOT Item 275. Microcracking is required. The organic content of the subgrade should not exceed 1%.
Lime treated or lime/cement treated subgrade will be included as a structural layer in pavement design calculations.	

Table 6.3.5D – Subgrade Treatment Options for Various Soil Types

Soil Type	Subgrade PI	PVR (in)	Subgrade Treatment Options
Sand Type B	0-20	0-1.0	8" Compacted Subgrade or 8" Cement Stabilized Subgrade*
Clay Type A1	< 20	0.3-1.0	8" Moisture Compacted Subgrade or 8" Cement Stabilized Subgrade or Type 2 Geogrid over 8" Moisture Conditioned Subgrade
Clay Type A2	20-35	1.0-2.0	8" Lime Stabilized Subgrade or 8" Cement Stabilized Subgrade or Type 2 Geogrid with 8" Lime Stabilized Subgrade
Clay Type A3	35-50	2.0-4.0	8" Lime Stabilized Subgrade or 8" Lime/Cement Stabilized Subgrade or Type 2 Geogrid with 8" Lime Stabilized Subgrade
Clay Type A4	>50	4.0 +	10" Lime/Cement Stabilized Subgrade

* Cement stabilized subgrade (min 11%) must be performed at North Padre Island, Mustang Island and Flour Bluff areas

Table 6.3.5E - Geogrid Requirements

(To be approved by the Director of Public Works)

Geogrid	The use of a City-approved geogrid without lime stabilization is an acceptable option only for Type A1 clay soils having a subgrade PI<20 The use of geogrid for Clay Types A2 and A3 clay soils is allowed if used in conjunction with lime stabilized subgrade.
	Considerations for using geogrid in place of lime-modification include speed of construction, same day restoration of access to driveways, protection from plastic deformation or loss of soil strength in soil layers below the improved zones, and other considerations such as the actual PI of the subgrade as outlined in this section.
	City-approved geogrid includes any geogrid classified as Type 2 geogrid by TxDOT under the most current version of TxDOT Departmental Materials Specification DMS-6240 per City Standard Specification Section 022040 Street Excavation.
	The layer coefficient ratio (LCR) for flexible pavement design with geogrid shall not exceed 1.2.

Table 6.3.5F Utility Trench Cement Stabilized Sand Requirements

Cement Stabilized Sand for Utility Trench Backfill	PI<20 for stabilization of utility trenches
	Shall contain a minimum of 2 sacks of Standard Type I Portland cement per cubic yard of sand and compacted to not less than 95% Standard Proctor density per City Standard Specification Section 022020 Excavation and Backfill for Utilities.

Table 6.3.5G Alternative Pavement Materials, Private Development Pavement and Public Roadway Pavement Considerations
(To be approved by the City Departments as outlined)

Alternate Pavement Materials **(Alternative materials to be approved by the Director of Public Works)**	Alternative pavement materials may be used where the existing soil or subsurface conditions, or the alternative materials, provide a level of drivability comparable to the materials otherwise required by this section.
	Proposals for alternative pavement materials with supporting engineering documentation may be submitted to the City for consideration for use.
	The combination of materials will be allowed for the various layers of the pavement structure as shown in below table.
Private Development Pavement	The Director of Development Services in consultation with the **Director of Public Works** in accordance with the standards provided herein must approve the pavement combination for private development.
Public Roadway Pavement (Bond/Capital improvements Projects)	The **Director of Engineering** must approve the pavement combination for public work.

Table 6.3.5H Curb & Gutter and Street Cross Slope Requirements

Curb & Gutter	Curb and gutter shall be installed as shown on the City Standard Details and as required in the appropriate road section. The treated subgrade and flexible base shall extend at least 2 feet beyond the back of curb. Transitions between the curb and gutter sections to either existing curb and gutter sections or roadside ditches shall be detailed in such a way as to ensure positive drainage to the nearest drainage system.
Cross-slopes	The road section cross-slope from the crown to the gutter shall be a consistent 2% minimum.
	The maximum acceptable cross-slope on new construction or full depth reconstruction is 4%.
	Crown to crown transitions are required at intersections and neither concrete nor asphalt valley gutters are allowed.

Table 6.3.5I – Pavement Materials Requirements by Pavement Type and Layer

Type	**Layer**	**Material/Treatment**		**Standard or Specification**
All	Subgrade Stabilization	Density Requirement	95% Standard Proctor Density	ASTM D698
		Moisture Requirement	0 to +4% of OMC	
		Lime Stabilization	Type A Clay Soils Only	TxDOT 260; TEX 121-E
		Cement Stabilization	Type B Sandy Soils and Type A Clay soils with PI<25.	TxDOT 275
		Lime Modification w/ Cement Stabilization	Type A4 Clays	TxDOT 260 (lime); TxDOT 275 (cement)
	Flexible Base	Only TxDOT Type A, Gr. 1-2 crushed limestone base allowed on City roadway projects without pre-approval		
		Density Requirement	98% Modified Proctor Density	ASTM D1557
		Moisture Requirement	+ or - 2%	
		Cement Stabilization	Optional	TxDOT 275
		Geogrid	Only for PI<20 or used in combination with lime stabilized subgrade for Type A2 or A3 Clays	TxDOT DMS-6240; City of CC Section 022040
Flexible	Seal Coat	One-Course Surface Treatment		TxDOT 306/316
	Prime Coat	MC-30		TxDOT 310
	HMAC Base Course	Type B	2.5-in (min)	TxDOT 300/334
	Tack Coat			--
	HMAC Surface Course	Type D		TxDOT 300/334
Rigid	HMAC Bond Breaker	Type D		TxDOT 300/334
	Portland Cement Concrete Pavement	Reinforcement	Continuously Reinforced	TxDOT 360
			Jointed Reinforced	TxDOT 361

Table 6.3.5J Min. Pavement Layer Thickness

Pavement Type	Roadway Type	Material & Type	Minimum Thickness	Additional Guidance
All	All	Flexible Base	6-in.	2 feet behind curb for urban roads and 2 feet beyond the edge of pavement for rural roads
All	All	Asphalt Treated Base	4-in.	-
All	All	Lime Treated Subgrade	8-in.	for stabilization or modification
All	All	Cement Treated Subgrade	8-in	for stabilization or modification
All	All	Lime/Cement Treated Subgrade	8-in	for stabilization or modification
HMACP	All	One-Course Surface Treatment	One Course	for all flexible base under HMACP
HMACP	All	Base Course (Type B)	2.5-in.	-
HMACP	All	Surface Course (Type D)	1.5-in.	-
HMACP	Left and Right Turn Lanes	Flexible Base	12-in.	-
HMACP		Asphalt Paving Surface Course (Type D)	4-in.	-
PCCP	All	Bond Breaker (Type D)	1-in.	per geotechnical report
PCCP	All	Portland Cement Concrete Pavement	6-in.	-

Table 6.3.5K Min. Residential Section on Type A1-A4 (Clay) Soils using HMACP – Section L-1 (A-B)

	Soil Type	Subgrade Treatment Options	HMAC	Flexible Base (Type A, Gr. 1-2)	Treated Subgrade
Section L-1 (A-B)	Clay Type A1	Compacted Subgrade or Cement Stabilized Subgrade or Type 2 Geogrid with 8" moisture conditioned subgrade	2"	6"	8"
	Clay Type A2	Lime Stabilized or Cement Stabilized or Type 2 Geogrid with lime stabilized subgrade (8%)	2"	8"	8"
	Clay Type A3	10" Lime Stabilized or 10" Lime/Cement Stabilized or Type 2 Geogrid with 10" Lime Stabilized Subgrade	3"	9"	10"
	Clay Type A4	10" Lime/Cement Stabilized Subgrade	3"	10"	10"

Table 6.3.5L Min. Pavement Section on Type A1-A4 (Clay) Soils using HMACP – Minor Residential Collector (C1) and Parkway Collector (P1)

Street Class.	Soil Type	Subgrade Treatment Options	HMAC	Flexible Base (Type A, Gr. 1-2)	Treated Subgrade
Minor Residential Collector (C1) and Parkway Collector (P1)	Clay Type A1	Compacted Subgrade or Cement Stabilized Subgrade or Type 2 Geogrid with 8" moisture conditioned subgrade	4”	11”	8"
	Clay Type A2	Lime Stabilized or Cement Stabilized or Type 2 Geogrid with lime stabilized subgrade (8%)	4”	11”	8"
	Clay Type A3	10” Lime Stabilized or 10" Lime/Cement Stabilized or Type 2 Geogrid with 10" Lime Stabilized Subgrade	4”	11”	10"
	Clay Type A4	10" Lime/Cement Stabilized Subgrade	4”	11”	10"

Table 6.3.5M Min. Pavement Section on Type A Clay Soils using HMACP

Street Class.	Subgrade Treatment Options	HMAC	Flexible Base (Type A, Gr. 1-2)	Lime Treated Subgrade
Secondary Collector (C2)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" Lime Stabilized Subgrade	4.5"	11"	10"
Primary Collector (C3)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" Lime Stabilized Subgrade	4.5"	13"	10"
Minor Arterial (A1)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" moisture conditioned subgrade	4.5"	15"	10"
Secondary Arterial (A2)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" moisture conditioned subgrade	5"	15"	10"
Primary Arterial (A3)	Lime Stabilized Subgrade or Type 2 Geogrid with 10" moisture conditioned subgrade	5.5"	16"	10"

Table 6.3.5N Min. Section on Type A (Clay) Soils using PCCP

Structural Material	Residential Section L-1 (A-B)	Minor Residential Collector (C1) and Parkway Collector (P1)	Secondary Collector (C2)	Primary Collector (C3)	Minor Arterial (A1)	Secondary Arterial (A2)	Primary Arterial (A3)
Concrete (4,400 psi min)	6"	7"	7.5"	8"	8.5"	9"	9.5"
HMAC Bond Breaker (Type D)	1"	1"	1"	1"	1"	1"	1"
Flexible Base (Type A, Grade 1-2)	6"	6"	6"	6"	6"	6"	6"
Subgrade	8" Lime Stabilized	8" Lime Stabilized	10" Lime Stabilized	10" Lime Stabilized	10" Lime Stabilized	10" Lime Stabilized	10" Lime Stabilized

Table 6.3.5O Min. Structural Pavement Sections on Type B (Sandy) Soils using HMACP

Structural Material	Section L-1 (A-B)	Local Minor Residential Collector	C1 Collector	C2 Collector	C3 Collector	Minor Arterial (A1)	Secondary Arterial (A2)	Primary Arterial (A3)
HMAC Pavement (Type D)	2"	3"	3.5"	4”	4"	4”	4.5"	5"
Flexible Base (Type A, Grade 1-2)	6"	9"	11"	11”	13"	13"	14"	14”
Subgrade	8" Cement Stabilized	8" Cement Stabilized	8" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized

Table 6.3.5P Min. Pavement Section on Type B (Sandy) Soils using PCCP

Structural Material	Section L-1 (A-B)	Local Minor Residential Collector	C1 and P1 Collector	C2 Collector	C3 Collector	Minor Arterial (A1)	Secondary Arterial (A2)	Primary Arterial (A3)
PCCP (4,400 psi min)	6"	6"	6.5"	7"	7.5"	8"	8.5"	9"
HMACP Bond Breaker (Type D)	1"	1"	1"	1"	1"	1"	1"	1"
Subgrade	8" Cement Stabilized	8" Cement Stabilized	8" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized	10" Cement Stabilized

6.3.3 Design Parameters Specific to Rigid Pavements

a. There are several design parameters required by the 1993 AASHTO Guide that are specific to rigid pavements. The following sections provide guidance regarding these parameters for roadways designed for the City as outlined in the following table.

Table 6.3.6A Rigid Concrete Pavement Requirements

28-day Concrete Modulus of Rupture	The Mr of concrete is a measure of the flexural strength of the concrete as determined by breaking concrete beam test specimens. A modulus of rupture of 680 psi at 28 days shall be used with the current City specification for concrete pavement. If a different value is used it must be documented with an explanation.
28-day Concrete Elastic Modulus	Elastic modulus of concrete is an indication of concrete stiffness and varies depending on the coarse aggregate type used in the concrete. A modulus of 5,000,000 psi shall be used for City pavement designs. If a different value is used it must be documented with an explanation.
Load Transfer Coefficient	The load transfer coefficient is used to incorporate the effect of dowels, reinforcing steel, tied shoulders, and tied curb and gutter on reducing the stress in the concrete slab due to traffic loading and therefore causing a reduction in the required concrete slab thickness. Required Load Transfer Coefficients are shown in Table 6.3.4D
Drainage Coefficient	The drainage coefficient characterizes the quality of drainage of the subbase layers under the concrete slab. Good draining pavement structures do not give water the chance to saturate the subbase and subgrade; thus, pumping is not as likely to occur. Subbase shall be designed to be dense-graded, non-erosive, and stabilized. Required Drainage Coefficients are shown in Table 6.3.4E.
Joint Spacing and Details	Construction joint spacing should not exceed 15 ft in either the longitudinal or transverse direction. The depth of saw cut should be a minimum of ¼ of the slab depth (⅓ the slab depth is recommended) if utilizing a conventional saw or 1 inch when using an early entry saw (early entry sawing is recommended). The width of the joint will be a function of the sealant chosen to seal the joint. It is recommended that a joint seal be utilized to minimize the introduction of incompressible material into the joint. It is recommended that dowel bars be used to provide load transfer and reduce differential movement (or faulting) across transverse joints. Dowels should be smooth #9 bars (Grade 60 steel) spaced 12 inches on center with an embedment length of at least 8 inches. Tie bars should be used to tie longitudinal joints within the pavement lanes and at the shoulder. Tie bars should be deformed #4 bars at a minimum (Grade 60 steel) spaced 36 inches on center with a minimum length of 30 inches. Isolation joints must be used around fixed structures including light standard foundations and drainage inlets to offset the effects of differential horizontal and vertical movements. Pre-molded joint fillers should be used around the fixed structures prior to placing the concrete pavement to prevent bonding of the slab to the structure and should extend through the depth of the slab but slightly recessed from the pavement surface to provide room for the joint sealant.

b. Continuously reinforced concrete pavements (CRCP) is a type of concrete pavement that does not require any transverse contraction joints. Transverse cracks are expected in the slab, usually at intervals of 1.5 - 6 ft (0.5 - 1.8 m). CRCP is designed with enough embedded reinforcing steel (approximately 0.6-0.7% by cross-sectional area) so that cracks are held together tightly. Determining an appropriate spacing between the cracks is part of the design process for this type of pavement. CRCP design for City of Corpus Christi projects should be performed in general accordance with the requirements of the TxDOT Pavement Design Manual (June 2021). CRCP designs generally cost more than JPCP or JRCP designs initially due to increased quantities of steel. However, they can demonstrate superior long-term performance and cost-effectiveness. In this area, a big advantage is the reduced soil moisture penetration through the concrete due to reduced jointing. Subgrade softening and pavement deterioration in the joint areas is therefore reduced considerably resulting in longer pavement life and better ride quality. CRCP also makes a good candidate for resurfacing with asphalt concrete due to its tight crack widths and minimal vertical movement between adjacent joints due to restraint from the steel which reduces the frequency and severity of reflective cracking.

6.3.4 Guidance for Designers and Engineers

a. The following tables discuss Roadway Design Approach for Roadway Designers and Geotechnical Engineers, the Approach and Requirements for the Type B sand soils and the Type A clay soils in the Corpus Christi area including the subgrade stabilization methods such as geogrid on clay soils, lime stabilization of Type A2, A3 & A4 clay soils, cement stabilization of Type A1 clay soils and Type B sand soils and lime/cement stabilization for Type A3 or A4 clay soils.

Table 6.3.7A Roadway Design Approach

Roadway Design Approach for Roadway Designers and Geotechnical Engineers	Roadway designers and geotechnical engineers shall utilize a combination of subgrade treatments, road base, road base treatments, bond breaker, and HMACP or PCCP pavement to form the structural design section for City roadways. All layers in the section shall contribute to the structural strength of the pavement based on typical design practices. Some layers contribute to moisture control, such as lime-modified subgrade, bond breakers, and seal coats, while other layers contribute to structural strength or structural stability in the section such as moisture-controlled/density-controlled subgrade, cement-treated subgrade, geogrid, lime-stabilized subgrade, moisture-controlled/density-controlled base, cement-treated base, and HMACP and PCCP. All layers should be working together to reduce differential movements, deformations, and failures based on design guidance for level of service/reliability level for each roadway type in the City's Unified Development Code (UDC), UTP, and as shown in the IDM.
	For all types of paving, rigid paving or flexible paving, a stable platform for building the roadway must be achieved ahead of pavement construction. One key requirement to achieve a stable roadbed platform is the required use of cement-stabilized sand in utility trenches per City Standard Specification Section 022020 Excavation and Backfill for Utilities to prevent settlement and deformation of utility trenches under the roadway pavement.
	For the pavement design of a particular roadway segment, geotechnical engineers will provide a variety of pavement sections for use by the City and the design engineer during the pavement selection process. All geotechnical reports will include both flexible and rigid pavement section options for roadways unless specifically scoped otherwise. These pavement sections will include cement-stabilized subgrade in sand areas, lime-stabilized subgrade in mid to high PI clay areas and lime-modified subgrade with or without geogrid in mid to low PI clay areas. The geotechnical engineer has the option of offering sections with cement stabilized base in low PI clay or sand or lime-modified in clay areas. The geotechnical engineer has the option of offering geogrid stabilized sections in Type A1 Clays and can be used in conjunction with lime in Type A2 and A3 Clays. Lime/cement stabilization should be used on the extremely high PI Type A4 clays.

Table 6.3.7B Approach for Type "B" Sandy Soils and Type "A" Clay Soils

Approach for Type "B" Sandy Soils	For sandy soils, such as low PI Type B soils primarily located at North Beach, Flour Bluff, and Padre and Mustang Islands, it is a requirement to cement stabilize the subgrade, which is a very fine sand, to avoid issues with localized collapses and deformations for both flexible and rigid pavements. Cement stabilization of roadway base may also be considered.
General Approach for Type "A" Clay Soils - Lime Stabilization, Lime/Cement Stabilization or Geogrid	For clay soils, it is a requirement to add lime to minimize the improved compacted subgrade layer from shrink/swell cycles or loss of soil strength and bearing capacity. The addition of lime is either to achieve lime modification to create a stable building platform or to reach a specified contribution to the pavement structural value or both. Lime modification alone may be insufficient to prevent differential movement in extreme wet/dry events and the addition of geogrid or cement stabilization shall be considered to improve pavement performance and life for lime-modified subgrade. Geogrid can also replace up to 8 inches of lime-modified subgrade under certain circumstances as outlined herein.

Table 6.3.7C Subgrade Improvement – Minimum Thickness

Subgrade Improvement Min. Thickness	Geotechnical engineers will use a representative PI based on the mean of PI measurements plus ½ their standard deviation. Subgrade improvements will be for a minimum of 8-inches thickness for all roadways. Typical guidance on the application of subgrade treatments is as shown Table 6.3.5C and Table 6.3.5D.

Table 6.3.6D Type "A" Clay Soils - Lime Stabilization

Type "A" Clay Soils - Lime Stabilization	For higher PI clays (PI > 20), the addition of lime sufficient to achieve lime stabilization is typically required to minimize shrink/swell and the potential for loss of soil strength in the improved layer and to create a stable building platform. Lime stabilization is also required to achieve a specified soil strength in the pavement section to bridge over areas of varying soil strength in the soil layers below the improved zone, as well as to reduce supersaturation of the subgrade that would lead to loss of soil strength followed by rutting and pumping. Lime stabilization does not require the use of geogrid. The Engineer will determine the sulfate content of the existing subgrade in accordance with Tex-145-E and organic content in accordance with Tex-148-E before lime treatment begins. Suspend operations when material to be treated has a sulfate content greater than 7,000 ppm or an organic content greater than 1.0% and proceed as directed. For lime-stabilized sections, geogrid is not required and shall not be substituted for lime stabilization with soils having a PI>20. The minimum thickness for lime stabilized subgrade is 8-inches. Lime modification alone may be insufficient to reduce differential movement in extreme wet/dry events and the addition of geogrid or utilizing lime/cement stabilization shall be considered to improve pavement performance and life for lime-modified subgrade. Lime/cement stabilization increases subgrade strength and reduces moisture infiltration from the sides.

Table 6.3.6E Type “A” Clay Soils - Cement Stabilization

Cement Stabilization	Cement stabilization of Type A clay soils is not allowed unless the subgrade PI is or has been modified to below 30 and organics are less than 1%. In all cases of cement stabilization, whether for subgrade or base, microcracking must be employed ahead of applying the bond breaker/seal coat to prevent reflective cracking from moving up throughout the entire pavement profile to affect level of service or reliability at the pavement surface. Cement stabilization shall be executed according to TxDOT Specification Section 275.

Table 6.3.6G Lime/Cement Stabilization

Approach for Type "A" Clay Soils - Lime/Cement Stabilization	Lime-modified subgrades can also be stabilized with cement after a PI < 30 has been achieved. Lime-modified subgrade requires the contractor to work the lime into the specified subgrade layer rather than just proof-rolling, thereby providing a firm, dry, and stable platform on which to build up the pavement structure. In order for cement to be activated as a stabilizing agent, a PI < 30 is required, sulfate levels < 7,000 ppm are required and organic material is limited to <1%.

6.3.5 Guidance for Bidders and Contractors

a. The following table discusses considerations for Bidders and Contractors.

Table 6.3.7A Guidance for Bidders and Contractors

Bidders	Bidders are to bid per plan and specification. Bidders should seek to clarify any questions about alternate products or materials during the question-and-answer period. Bidders should not anticipate approval of alternate products or materials after award.
Contractors	Contractors shall install the product specified or called in the plans unless a value- engineering proposal has been presented by the Contractor through the Change process outlined in Specification Section 00 72 00 General Conditions and accepted by the City Engineer as indicated by his signature on the change agreement. All credits back to the City must be accounted for in any value-engineering agreement per 00 72 00, to include contract time and labor.
	The addition of geogrid to a lime-modified layer will be expected to add time and cost. For flexible pavement on low PI clays, the subtraction of lime modification and replacement by geogrid would be expected to subtract time and cost.
	Consideration for the use of geogrid in lieu of lime can be made to expedite construction, protect commercial or residential property, to quickly restore traffic o in other cases as outlined in this Section.
	Lime stabilization shall be executed according to TxDOT Specification Section 260 and TxDOT standard Tex 121-E.
	Cement stabilization shall be executed according to TxDOT Specification Section 275.
	Geogrid stabilization shall be provided according to TxDOT DMS-6240 and City Standard Specification Section 022040 - Street Excavation.