10 GENERAL ROAD DESIGN GOALS AND PROCEDURES

10 -1 All streets and roadways to be build within and made part of the City road system shall be designed to conform to these standards. Where standards are not definitive , design shall conform to good engineering practice approved by the Director of Public Works. The Caltrans Design Manuals generally provide guidance in " good engineering practice " of road design.

10 - 2 The Public Works Director may issue , modify , revise or cancel standards showing engineering and construction details for roadways and other construction.

10 - 3 Deviations from Right-of-Way and improvements of these standards shall be allowed only with the approval of the Public Works Director. Deviation from the technical requirements of the standards may be granted by the Public Works Director. Any request for deviation from the requirements of the standards must be accompanied by sufficient supporting data . The applicant requesting the deviations shall provide the supporting data well in advance and obtain the approval prior to utilizing the proposed deviation in his design.

10 - 4 Turning lanes at intersections and bicycle lanes may require Right - of - Way and improvement widths greater than those shown on the 100 - series standards.

10 - 5 Design loading for box culverts and bridges on all roadways shall be AASHTO H-20.

10 - 6 Vertical clearance on all roadways shall be 15' minimum .

10 - 7 Sight distance on all curvilinear roads shall be per Table-I.

11 GRADES

11 - 1 **LONGITUDINAL GRADE :**
All streets and roadways shall have minimum grade of 0.40% on straight reach. On curved alignment, minimum grade of 0.40% is required on outer radius of the curve. This will entail steeper grades along centerline.

11 - 1.1 Minimum grade of cross-gutter and spandrell flow line shall be 0.50% This grade will be required on centerline of the street parallel to the cross-gutter . Cross fall should not be adjusted to accomplish the required grades.

11 - 1.2 Minimum grade across " Knuckle " is 0.40% along outer curb. This will require steeper grades along centerline and inner curb

11 - 1.3 Minimum grade on flowline of a cul-de-sac shall be 0.40%. Adjust the centerline grade such that cross - fall ranges between 1.6% minimum and 3.6% maximum.

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11 - 2 **TRANSVERSE GRADE:**

More commonly known as cross fall shall be not less than 1.6%. Preferrable value of the cross fall is 2.0% . It shall not be more than 3.6% unless approval of higher value is granted by the Public Works Director.

11 - 3 **GRADE BREAKS:**

Grade breaks on all streets and roadways shall be limited to 0.5% maximum. Where grade differencial is greater than 0.5% vertical curve shall be required per table -2, section 12 - 2. A maximum of 1.0% grade break is allowed on curb-returns before a vertical curve is required. For the ease of plan-checking show your grade break points on profile. Also show tangent grades in parentheses when actual finish surface profile is a vertical curve. Grade breaks must not be closer together than the length of vertical curve for grade changes of 1.0%. See section 12-2, " vertical curves " in this text.

12 GEOMETRIC DESIGN STANDARDS

12 - 1 **HORIZONTAL CURVES:**

Minimum horizontal curve design criteria for street and roadways within the City jurisdiction shall be as summarized in Table-1.

TABLE - 1

MINIMUM HORIZONTAL CURVE DESIGN CRITERIA

DESIGN CRITERIA	RES. STREETS	COMM./ INDUSTR.	LOCAL/ SEC. ARTERIAL	PRIMARY ARTERIAL
Design Speed (m.p.h.)	30	35	45	55
Minimum Centerline Radius (feet)	200	300	850	1,150
Minimum horizontal Sight distance (feet)	200	250	370	510
Minimum reverse Curve tangent (feet)	100	200	300	500
Minimum approach tangent @ intersections (feet)	100	200	300	500

12 - 2 **VERTICAL CURVES:**

Minimum vertical curve design criteria for streets and roadways within the City jurisdiction shall be as summarized in Table-2.

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TABLE - 2 VERTICAL CURVE DESIGN CRITERIA

Minimum lengths of vertical curves to maintain required sight distances and smooth riding characteristics.

A = Algebraic difference in grades , for values of "A " between tabulated values, use next higher value.
B = Length of vertical curve at bulb end of cul-de-sac.

DESIGN SPEED		25 M.P.H.		30 M.P.H.		35 M.P.H.		40 M.P.H.		45 M.P.H.		50 M.P.H.		55 M.P.H.	
STOPPING SIGHT DISTANCE		160 FT.		200 FT.		250 FT.		310 FT.		370 FT.		440 FT.		510 FT.	
A	B	SAG	CREST	SAG	CREST	SAG	CREST	SAG	CREST	SAG	CREST	SAG	CREST	SAG	CREST
≤ 0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>0.5	10	10	10	10	10	10	10	10	10	20	20	20	20	30	30
1.0	10	10	10	20	20	20	20	20	20	30	30	30	30	50	50
1.5	10	20	20	20	20	30	30	30	30	40	40	50	50	70	100
2.0	10	20	20	30	30	40	40	40	40	60	80	80	200	100	330
3.0	20	30	30	40	40	80	50	130	160	180	280	240	420	300	570
4.0	20	80	30	130	70	190	170	250	270	320	400	400	560	480	760
5.0	30	130	60	180	130	250	230	330	350	410	500	500	700	600	950
6.0	30	160	100	220	170	300	270	390	420	490	600	600	840	720	1140
7.0	40	190	120	260	210	350	320	460	490	560	700	700	980	840	1330
8.0	40	220	150	300	230	400	360	520	550	650	800	800	1120	960	1520
9.0	50	240	180	330	260	450	410	580	620	730	900	900	1260	1080	1710
10.0	50	270	200	370	290	500	450	650	690	810	1000	1000	1400	1200	1900
11.0	60	300	220	400	320	550	500	720	760	890	1100	1100	1550	1350	2100
12.0	60	320	240	440	350	600	550	780	830	970	1200	1200	1700	1500	2300

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12-3 **MINIMUM CURB RETURN AND PROPERTY LINE RADII SHALL BE AS FOLLOWS :**

TABLE–3 MINIMUM RADII AT INTERSECTIONS

Type of Intersection	Curb Return	Property Line
Residential - Residential	25 feet	12 feet
Residential - Comm./ Ind.	30 feet	17 feet
Comm./ Ind. - Comm./ Ind.	30 feet	17 feet
Comm./ Ind. - Local/ Sec. Art.	30 feet	15 feet
Residential - Local/ Sec. Art.	30 feet	15 feet
Residential - Primary Art.	30 feet	15 feet
Comm./ Ind. - Primary Art.	35 feet	20 feet
Local/ Sec. Art. - Local/ Sec. Art.	35 feet	20 feet
Local/ Sec. Art. - Primary Art.	40 feet	25 feet
Primary Art. - Primary Art.	40 feet	25 feet

12-4 **ROAD WIDTH TRANSITION TAPERS:**

When constructing a roadway that will directly connect with an existing roadway of less width, it is necessary to install a transition taper between the two. The length of taper depends upon the offset difference between the outside travelled edge of the two sections and the speed limit or design speed as shown in the taper formula below.

These values are not to be used in the design of speed change or left turn storage lanes

MINIMUM ROAD WIDTH TRANSITION TAPERS

TAPER FORMULA:

$L = S \times W$ For speeds greater than 40 mph

$L = \frac{WS^2}{60}$ For speeds of 40 mph or less.

WHERE:

L = Length of taper (min. 100')

S = Numerical value of posted speed limit or 85 percentile speed

W= Width of offset.

13 ASPHALT CONCRETE PAVEMENT DESIGN

13-1 GENERAL PRINCIPLES

The design of asphalt concrete pavement is based on the principle of layers of progressively decreasing strengths from the finished surface to the sub-grade. In each case, the finished surface consists of a layer of asphalt concrete pavement of the thickness computed by the design formulas, but not less than a specified minimum thickness.

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The design method provides a numerical solution to the thickness of any layer based on the following:

a. The Traffic Index, a measure of the amount and type of truck traffic that is expected over the 20-year period following construction.

b. The physical strength, measured by gravel equivalent, of the layer being designed.

c. The physical strength, measured by R-Value, of the layer immediately below the layer being designed.

d. The minimum physical strength, measured by R-Value, of the sub-grade material.

e. The thickness and physical strength, measured by gravel equivalent, of the material above the layer being designed, if any.

By varing the types of materials used, a number of different, acceptable pavements can be designed for each combination of Traffic Index and sub-grade R-Value.

13-2 ECONOMIC CONSIDERATIONS:

The relative costs of the materials making up the layers of pavement vary from time to time resulting in differing combinations of layers being the most economical at any given time.
In selecting a complete pavement design, the following should be taken into consideration:
a. Sub-grade soils can be improved in strength by several types of treatment which do not require the material to be removed from the site.

b. Base materials with R-Values less than that of Standard Specification Crushed Miscellaneous Base (C.M.B.) can be used economically with the lower Traffic Indices. A note on the plans or a special provision is needed.

c. Existing bases and surfacing can be reused. This may require treatment in place or removal and reprocessing.

d. Materials cannot be compared on cost per ton basis alone because:

(1) Higher strength materials require less thickness when used in place of lower strength materials.

(2) Elimination of a complete layer by thickening the layer above may result in savings in construction costs not reflected in per ton costs alone.

(3) Gravel equivalent of A.C. increases when thickness is over 0.4 feet.

e. Thinner overall thickness of the layered pavement sections results in less excavation and may avoid interference with or

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damage to utility and drainage facilities.

f. Current scarcity in the supply of any material used.

Several alternate sections should be designed, the overall cost of each estimated, and the most economical section specified. Where costs are nearly equal or where relative costs of materials are changing rapidly, it may be desirable to provide more than one acceptable design from which the contractor can choose the one to construct.

13-3 DESIGN METHOD

13-3.1 NOMENCLATURE

T= Thickness of layer in feet.
TI = Traffic index from standard drawings plates or a greater value indicated by a traffic engineering study.
GF = Gravel factor of material in a layer.
GE = Gravel equivalent of the pavement or a layer. The theoretical thickness of the pavement or layer if composed entirely of material with a GF of one.
SF = Safety factor. An additional thickness of A.C. expressed as gravel equivalent.
R = Minimum resistant R-Value of material.
AC = Subscript referring to Asphalt Concrete layer.
B = Subscript referring to Base layer.
SB = Subscript referring to Subbase layer.
SG = Subscript referring to Subgrade.
MIN = Subscript referring to Minimum Allowable Thickness of a layer.

13-3.2 CONSTANTS FOR AC

$GF = 2.5$ for $TI \leqslant 5$

$GF = \frac{5.67}{\sqrt{TI}}$ for $TI > 5$

T_{AC} min. over Base material or stabilized subgrade = 0.25 ft.

T_{AC} min. over unstabilized subgrade = 0.33 ft.

13-3.3 CONSTANTS FOR BASES AND SUBBASE

MATERIAL	R*	GF	SF_{AC} **	T Min., Ft.
Select subbase	60	1.0	0	0.33 (Subbase only)
CAB ~~CMB~~	80	1.1	0.16	0.33
Lime Treated Base	80	***	0.18	0.50
Soil Cement	80	1.2	0	0.50
Bituminous Stabilized Base	80	1.3	0	0.50
Cement Treated Base	80	1.2	0.18	0.50

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*Maximum R-Value , lesser values must be used if standard specifications are modified.

**For T.I. $<$ 8.0, $SF_{AC} = 0$

***LTB GF = 0.9+(Unconfined compressive strength in PSI/1000)

13-3.4 CONVENTIONAL DESIGN

A layered system of A.C., base and sub-base over the subgrade. The material in each layer must have a higher R-Value than the material below it. The thickness of each layer is designed, starting with the A.C. surface layer and working down, as follows:

a. $GE_{AC} = 0.0032 \times TI \times (100 - R_B) + SF_{AC}$

b. $T_{AC} = GE_{AC} / GF_{AC}$ If T_{AC} 0.25, use $T_{AC} = 0.25$ft.

c. $GE_B = 0.0032 \times TI \times (100 - R_{SB}) - (T_{AC} \times GF_{AC})$

d. $T_B = GE_B / GF_B$ If $T_B < T_{MIN}$, use $T_B = T_{MIN}$

e. $GE_{SB} = 0.0032 \times TI \times (100 - R_{SG}) - (T_{AC} \times GF_{AC}) - (T_B \times GF_B)$

f. $T_{SB} = GE_{SB}$ If $T_{SB} < T_{MIN}$, then either

(1) $T_{SB} = T_{MIN}$ or

(2) $T_B = (GE_B + GE_{SB}) / GF_B$ and $T_{SB} = 0$

13-3.5 THICK LIFT DESIGN

An A.C. surface layer , 0.3 feet or more in thickness , placed either directly on the subgrade (stabilized* or unstabilized) or over a layer of base material* designed as follows:

a. $GE_{AC} = 0.0032 \times TI \times (100 - R_{SG}) - T_B \times GF_B$

b. $T_1 = GE_{AC} / GF_{AC}$

c. If $T_1 \leqslant 0.4$ ft., $T_{AC} = T_1$

d. If $T_1 > 0.4$ ft., $T_2 = \left[GE_{AC} - (0.4 \times GF_{AC}) \right] / (1.3 \times GF_{AC})$

e. If $T_2 \leqslant 0.4$ ft., $T_{AC} = 0.4$ft. $+ T_2$

f. If $T_2 > 0.4$ ft., $T_3 = \left[GE_{AC} - (0.92 \times GF_{AC}) \right] / (1.5 \times GF_{AC})$

g. Then $T_{AC} = 0.8$ ft. $+ T_3$

* Base or stabilized subbase shall be 0.5 ft. or thicker.

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14 INTERSECTION

All at-grade intersections provide linkage between two or more streets. Design considerations should be such that intersections provide smooth riding characteristics and ample unobstructed sight distances. Minimize the use of cross-gutters, whenever possible. Also , all intersections and certain approach distances withstand greater acceleration and deceleration actions.
To help minimize the wear and tear of the pavement , increase the design value of traffic index by 0.5 and increase the structural section. If the intersection is formed by the junction of two or more roadways, then the entire intersection shall be designed for the upgraded T.I. of the street with higher T.I. . The entire intersection means, full pavement width traversing along main street from the beginning of first curb return to the end of last curb return plus the maximum coverage of the secondary street by extending perpendicular lines from the farthest end of curb returns.
The approach distances shall be those sight distances given in Table I (sub-section 12-I) and measured beyond the limit of the intersection as defined above. The approaches on main street shall be designed for the T.I. = designated T.I. + 0.5 of the main street and similarly the approaches on secondary street shall be designed for T.I. = designated T.I. + 0.5 of the secondary street.
This could be accomplished by thickening asphalt and / or base section or any combination thereof . Also , it is desirable to bring up to pavement surface and reduce the curb height thereby. This helps in the design of the access ramps for physically handicapped and forces the drainage flow away from the intersection.

15 MATERIAL TESTING

15-1 ADMINISTRATIVE

15-1.1 All design for thickness of pavements, including soils testing , and all control testing during construction shall be performed by a Materials Engineer.

15-1.2 A Materials Engineer acceptable to the Director of Public Works shall be employed and paid by the developer of any land development project and by permittee on jobs requiring permits. The Materials Engineer , or a consulting Engineer employed by the City , shall be the Materials Engineer on City projects.

15-1.3 A materials Engineer shall be a Registered Civil Engineer knowledgeable in the field of soil mechanics and road materials.

15-1.4 Since A.C. (viscocity) varries from refinery to refinery , use of A.C. 4000 (as called on Std. Plates) may be substituted with A.R. 8000 by the Engineer.

15-2 TEST METHODS AND REPORTS

15-2.1 Materials shall be tested in accordance with "City Standard Specifications" , as well as those supplementary test methods required by the Director of Public Works.

15-2.2 A soil classification survey (Unified Soil Classification System) shall be performed at appropriate intervals in the street areas of subdivisions to determine the areas with similar soils.
A limited number of soils tests shall be made, as required, prior to pavement design. Tests for pavement design shall not be done until rough grading has been completed to within one foot of final finish surface grade, nor until it is assured that the soils sampled are representative of those at the final grade.

15-2.3 The test report shall include the results of sampling and testing, work sheets for the subgrade strength tests, a plan showing material limits and areas represented by a given subgrade strength test and specific recommendations derived from the test data given. Any other test data not required but which will have an effect on the recommendations shall be included.

15-2.4 During construction a sufficient number of tests shall be made to assure that the quality of construction and component materials is equal to that required by specification. These specified requirements include, but are not limited to , fill densities and supporting qualities, subgrade and base quality and compaction, and asphalt concrete quality and compaction.
When treated soil or aggregate is used, a quality control plan must be submitted and approvedby the City of Oxnard.

15-2.5 Though materials may be tested for conformity to specification while stockpiled, final acceptance of these materials will be subject to their conformity to specification requirements when in final position on the work.

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20 GENERAL STREET LIGHTING, TRAFFIC SIGNALS, TRANSIT.

20-1 STREET LIGHTING GUIDELINES

TYPE STREET	LIGHTING
Local Residential	5800 Lumen High Pressure Sodium Vapor (HPSV) one side at 180 to 240 foot spacing.
Heavily - Traveled Collector street	9500 Lumen HPSV one side at 180 to 240 foot spacing
Thoroughfare	9500 Lumen HPSV in median at 180 - 240 foot spacing on staggered sides of pole except at intersections or along high pedestrian traffic areas where two lights per pole shall be placed. Where no median 9500 Lumen HPSV on one side at 180 to 240 foot spacing.

20-2 TRAFFIC SIGNALS

Caltrans standard plans and specifications are made a part of plans with following special provisions :

1. Conduits shall be rigid metallic. Min cover 36" over buried conduits.
2. Pedestrian signals shall be type A.
3. Detector loop wire shall be type I. Lead in cable shall be type B.
4. Luminaires shall be 200 WHPSV (Watts High Pressure Sodium Vapor), cutoff type.
5. Internally illuminated street name signs shall be double-faced, type A.
6. At least one telephone drop must be provided to each isolated signal or each interconnected system. Signal interconnect conduit to be installed along all arterial highways.

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7. Electrical service enclosure shall be type III BF.

8. Concrete pullboxes shall be used.

9. Splices shall be Insulated by Method B. Conductors # 8AWG or larger shall be spliced by use of "C" shaped compression connectors.

10. Type 170 signal controller equipment in type 332 cabinet (anodized aluminum) modified to provide 2 serial parts on 170 unit and 412/64 program module configured with 27-256 EPROM with 8K RAM and 4K zero power RAM.

11. Signal head reflectors shall be ALZAK.

12. Back plates shall be metallic . Signal heads may be plastic.

20-3 TRANSIT FACILITIES

Where required , bus pullouts shall be designed per Plate 200&201. When only a bus pad is required the pavement section shall be designed for T.I. = 10.5
The dimensions of the pad shall be 60 feet × 10 feet unless otherwise directed.

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