CHAPTER 1

GENERAL

1-1. Purpose and scope. This manual establishes the geometric design criteria for roads, streets, walks, and open storage areas. This manual sets forth the approaches and traffic flow criteria for guidance in determining types and configurations best suited for mobilization construction. This manual presents general criteria and is intended for use in conjunction with EM 1110-3-131, EM 1110-3-132, EM 1110-3-136, and EM 1110-3-150.

1-2. Definitions of pertinent terms. The definitions of terms relative to highway design are given in lists of definitions presented in the manuals of AASHTO as a part of specific procedures referenced from this manual, D6.1 and as described below.

a. Access highways. An access highway is an existing or proposed public highway which is needed to provide highway transportation services from an Army reservation to suitable transportation facilities. This will not include installation highways within the boundary of an Army reservation, but may include a highway through an Army reservation that has been dedicated to public use if reasonable assurance can be given that future closure to public use will not be required. The design and construction of access highways are normally the responsibility of the state, county, or local authorities. The design criteria of these authorities will be used for access road construction but with due consideration given to the mobilization effort.

b. Installation highways. Installation highways include all roads and streets within the site limits of Army installations which are constructed and maintained by the Department of Defense. All installation highways are classified in accordance with their relative importance to the installation as a whole and with respect to the composition, volume, and characteristics of the traffic using them. Design criteria for roads and streets within Army installations are presented herein.

1-3. Highway planning. The planning of the general road system is an integral part of installation master planning. Major objectives of master planning are the grouping of related functions reasonably close to each other and the interrelating of land-use areas for maximum efficiency, speed of construction, and economy of operation. The connecting road system should be planned in keeping with these objectives to minimize on-post travel and permit the optimum circulation of traffic originating both outside and within the installation. Traffic studies may not be available during a mobilization situation, so good engineering judgment and assessment of current and/or near future needs must be made to determine traffic

requirements. The geometric design of highway facilities should provide for safe, smooth, and convenient traffic movement consistent with time limitations, topographical conditions, and to the extent possible, economical construction. Existing roads and streets at Army installations can be classified in accordance with requirements presented in tables 1-1 and 1-2. The elements to be given primary consideration in such classifications are pavement width, shoulder width, degree and length of slopes (grade), and passing sight distance. Values for these elements should be essentially equal to or greater than the minimum requirements for classification assigned. All of the requirements in table 1-1 or 1-2 should be considered, but requirements other than those just listed can be given greater latitude.

1-4. Traffic. The volume and composition of the traffic determines the geometric requirements for roads, streets, walks, and open storage areas. Type, volume, character, frequency, and composition of traffic at Army installations are related to size, type, and mission of the installation. The size, type, and mission of the installation provide information as to its functional requirements, indicating character and size of vehicles. Types of vehicles, types of terrain, and frequency of use establish the traffic classification in which roads and streets fall. The system of highway classification outlined and defined above is believed sufficiently broad for the classification of all roads and streets within an Army installation regardless of type and mission. Classification reflecting character of traffic is based upon the characteristics and dimensions of existing civilian and Army vehicles. Army vehicles include not only wheeled vehicles but also combined wheel and tracked vehicles. It is essential that the designer be aware of the vehicular traffic anticipated prior to selection of the type design to use on a particular project.

Table 1-1. Geometric Criteria for Classified Roads Within "Open" Areas of Army Installations (Rural Areas)

Design Controls and Elements	Class B Road[a] Two-Lane Road			Class D Road[a] Two-Lane Road			Class E Road[a] Two-Lane Road[b]		
	Flat	Rolling	Mountainous	Flat	Rolling	Mountainous	Flat	Rolling	Mountainous
Design Controls:									
Traffic composition:[1]									
T = 0%									
ADT	4,000-6,000	4,000-6,000	4,000-6,000	1,000-4,000	1,000-4,000	1,000-4,000	Under 1,000	Under 1,000	Under 1,00
DHV[2]	600-900	600-900	600-900	150-600	150-600	150-600	Under 150	Under 150	Under 150
T = 10%									
ADT	3,600-5,500	3,000-4,600	2,400-3,500	950-3,600	770-3,000	600-2,400	Under 950	Under 770	Under 600
DHV[3]	550-820	450-690	360-530	140-550	115-450	90-360	Under 140	Under 115	Under 90
T = 20%									
ADT	3,300-5,000	2,500-3,700	1,600-2,500	870-3,300	630-2,500	400-1,600	Under 870	Under 630	Under 400
DHV[3]	500-750	380-560	240-380	130-500	95-380	60-240	Under 130	Under 95	Under 60
T = 30%									
ADT	3,000-4,700	2,000-3,200	1,200-2,100	770-3,000	570-2,100	330-1,200	Under 770	Under 570	Under 330
DHV[3]	450-700	310-480	180-310	115-450	85-310	50-180	Under 115	Under 85	Under 50
Design speed, mph	70	60	50	55	45	35	55	45	35
Average running speed, mph	49	45	40	43	37	30	43	37	30
Cross-Section Elements:									
Pavements:									
Minimum width of traffic lanes, ft[4]									
With barrier curbs	12	12	12	10	10	10	10	10	10
Without barrier curbs	12	12	12	10	10	10	10	10	10
Minimum distance between barrier curbs, ft[5]	29	29	29	24	24	24	20	20	20
Desirable lateral clearance, to obstructions, ft	6	6	6	4	4	4	2	2	2
Normal cross slope, in./ft		1/8 to 1/4			3/16 to 3/8			1/4 to 1/2	
Curbs:[6]									
Types		See paragraph 3-2.b							

Table 1-1. Geometric Criteria for Classified Roads Within "Open" Areas of Army Installations (Rural Areas) (Continued)

Design Controls and Elements	Class B Road[a] Two-Lane Road			Class D Road[a] Two-Lane Road			Class E Road[a] Two-Lane Road[b]		
	Flat	Rolling	Mountainous	Flat	Rolling	Mountainous	Flat	Rolling	Mountainous
Offset for barrier curbs	2.5	2.5	2.5	2.0	2.0	2.0	0	0	0
Medians[7]	See figure 3-1								
Shoulders:[8]									
Minimum width, shoulders on roads without barrier curbs, ft	10	8	8	8	6	4	6	6	4
Normal cross slope, in./ft	3/8 to 1/2			1/2 to 3/4			3/4 to 1		
Type	Dustless and stable for all-weather use			Stabilized with select material			Compacted soil		
Guardrails, guideposts, and earth slopes	See figure 3-2								
Bridge clearance	See paragraph 3-3e								
Design Elements:									
Sight distance:									
Minimum stopping sight distance, ft	600	475	350	415	310	240	415	310	240
Minimum passing sight distance, ft	2,300	2,000	1,700	1,850	1,500	1,050	1,850	1,500	1,050
Horizontal alinement:									
Horizontal curves, maximum curvature									
Desirable maximum	1°30'	2°00'	3°00'	2°30'	3°30'	6°00'	2°30'	3°30'	6°00'
Absolute maximum[9]									
Where snow and ice are not factors	4°00'	5°30'	8°00'	7°00'	10°30'	18°00'	7°00'	10°30'	18°00'
Where snow and ice are factors	3°00'	4°30'	7°00'	5°45'	9°00'	16°30'	5°45'	9°00'	16°30'
Pavement widening	See table 3-1 and figure 3-3								

Table 1-1. Geometric Criteria for Classified Roads Within "Open" Areas of Army Installations (Rural Areas) (Continued)

Design Controls and Elements	Class B Road[a] Two-Lane Road			Class D Road[a] Two-Lane Road			Class E Road[a] Two-Lane Road[b]		
	Flat	Rolling	Mountainous	Flat	Rolling	Mountainous	Flat	Rolling	Mountainous
Vertical alinement:									
Grade:[10]									
Desirable maximum									
Percent	3	3	4	4	5	6	5	6	7
Critical length, ft[11]	1035	1035	720	720	550	450	550	450	375
Absolute maximum for permanent installations									
Percent	5	6	6	7	8	9	8	9	10
Critical length, ft[11]	1000	660	450	850	550	275	900	600	400
Absolute maximum for temporary installations									
Percent	6	7	8	8	9	10	10	11	12
Critical length, ft[11]	825	550	325	750	500	250	700	525	375
Minimum, percent		0.3				0.5			
Vertical curves[12]									
K for determining safe length									
Crest vertical curves	240	150	80	115	65	40	115	64	40
Sag vertical curves	140	100	70	85	60	45	85	60	45
Minimum length, ft	210	180	150	165	135	105	165	135	105

NOTES:

1 The symbol "T," with percentage limitations, represents the proportion of total traffic composed of buses, trucks, and track-laying vehicles; the remainder are light delivery trucks and passenger cars.

2 The DHV is equal to approximately 15 percent of the ADT.

3 These values show the mixed traffic volume which requires the same operational area as that required by traffic composed of light-delivery trucks and passenger cars. These DHV's are based on the indicated percentage of the daily volume and may be overconservative in some instances because the percentages of trucks, track-laying vehicles, etc., during peak hours are generally considerably lower than the average percentage during all hours.

4 The traffic lane widths indicated are for use on roads where the traffic will consist principally of vehicles with maximum overall widths of 8 ft. or less. For determining traffic lane width for excessive-width vehicles, see paragraph 3-1.b.

5 Distance shown is the minimum distance between face of curbs where Class B roads require more than 2-lanes, additional lane widths are to be added to minimum distance between curbs.

6 Generally, curbs will not be provided on roads in open areas. See paragraph 3-2 for exceptions on provision of curbs within open areas at Army installations. The curb offset is measured from the edge of the pavement to the vertical face of the curb on the curb portion of a combined curb and gutter.

7 Where traffic volume requires construction of multilane roads, opposing traffic should be separated by medians. Width and location of medians, median shoulders, and median curbs are discussed in paragraph 3-3.b.

8 There should be a color or textural contrast between pavement and shoulder surface sufficient to clearly define the pavement and shoulders in all types of weather.

Table 1-1. Geometric Criteria for Classified Roads Within "Open" Areas of Army Installations (Rural Areas) (Continued)

NOTES: (Continued)

9 Absolute maximum values shown were calculated on the basis of a maximum rate of superelevation of 0.10. Absolute value for horizontal curves will have to be recalculated if a maximum rate of superelevation other than 0.10 is used.

10 See paragraph 3-6.a. for exception to this criteria.

11 The term "critical length" is used to indicate the maximum length of a designated upgrade upon which a loaded truck can operate without an unreasonable reduction in speed. Methods for determination of critical length are discussed in paragraph 3-6.a.(1).

12 The minimum lengths of vertical curves are determined by multiplying "K" times the algebraic difference of grades (in percent).

a The DHV is in total vehicles per hour for all lanes in both directions.

b For single lane roads use criteria of Class E mountainous.

Table 1-2. Geometric Criteria for Classified Street Within "Built-up" Areas of Army Installations

Design Controls and Elements	Class B Street[a] Two-Lane Street		Class D Street[a] Two-Lane Street		Class E Street[a] Two-Lane Street	
	Flat	Rolling	Flat	Rolling	Flat	Rolling
Design Controls						
Traffic composition[1]						
T = 0%						
ADT[2]	7,500-10,000	7,500-10,000	2,100-7,500	2,100-7,500	Under 2,100	Under 2,100
DHV[2]	900-1,200	900-1,200	250-900	250-900	Under 250	Under 250
T = 10%						
ADT[3]	6,800-9,100	5,700-7,700	1,900-6,800	1,600-5,700	Under 1,900	Under 1,600
DHV[3]	810-1,090	680-920	230-810	190-680	Under 230	Under 190
T = 20%						
ADT[3]	6,200-8,300	4,600-6,300	1,800-6,200	1,300-4,600	Under 1,800	Under 1,300
DHV[3]	750-1,000	550-760	220-750	160-550	Under 220	Under 160
T = 30%						
ADT[3]	5,800-7,700	4,200-5,300	1,600-5,800	1,100-4,200	Under 1,600	Under 1,100
DHV[3]	700-920	500-640	190-700	130-500	Under 190	Under 130
Design speed, mph	50	40	40	30	40	30
Average running speed, mph	36	32	32	25	32	25
Cross-Section Elements:						
Pavements:						
Minimum width of lanes, ft[4]						
With barrier curbs						
Traffic	12	12	11	11	10	10
Parking[5]	None	None	8	8	8	8
Without barrier curbs						
Traffic	12	12	11	11	10	10
Minimum distance between barrier curbs, ft[4,6]						
With parking lanes[5]	None	None	41	41	36	36
Without parking lanes[7]	29	29	25	25	20	20
Desirable lateral clearance to obstructions, ft	6	6	4	4	2	2
Normal cross slope, in./ft	1/8 to 1/4		3/16 to 3/8			

Table 1-2. Geometric Criteria for Classified Streets Within "Built-up" Areas of Army Installations (Continued)

Design Controls and Elements	Class B Street[a] Two-Lane Street		Class D Street[a] Two-Lane Street		Class F Street[a] Two-Lane Street	
	Flat	Rolling	Flat	Rolling	Flat	Rolling
Curbs:[8]						
Types	See paragraph 3-2.b.					
Offset for barrier curbs, ft	2.5	2.5	1.5	1.5	1.5	1.5
Medians[9]	See figure 3-1					
Shoulders:[10]						
Minimum width, shoulders on streets without barrier curbs, ft	10	8	8	8	8	6
Normal cross slope, in./ft	3/8 to 1/2		1/2 to 3/4			
Type	Dustless and stable for all weather use					
Guardrails, guideposts, and earth slopes	See figure 3-2					
Bridge clearance	See paragraph 3-3e					
Design Elements						
Sight distance:						
Minimum stopping sight distance, ft	350	275	275	200	275	200
Horizontal alinement:						
Horizontal curves						
Absolute maximum for normal crown section	0°30'	0°45'	0°45'	1°30'	0°45'	1°30'
Absolute maximum for superelevated section[11]	5°30'	9°15'	9°15'	17°15'	9°15'	17°15'
Pavement widening	See table 3-1 and figure 3-3					
Vertical alinement:						
Grade						
Desirable maximum						
Percent	3	3	4	4	5	6
Critical length, ft[12]	900	550	750	475	400	200

Table 1-2. Geometric Criteria for Classified Streets Within "Built-up" Areas of Army Installations (Continued)

Design Controls and Elements	Class B Street[a] Two-Lane Street		Class D Street[a] Two-Lane Street		Class E Street[a] Two-Lane Street	
	Flat	Rolling	Flat	Rolling	Flat	Rolling
Absolute maximum for permanent installations						
Percent	4	5	6	7	7	8
Critical length, ft[12]	675	200	500	200	450	175
Absolute maximum for temporary installations						
Percent	6	6	7	8	8	9
Critical length, ft[12]	500	275	450	200	200	150
Minimum, percent	0.3				0.5	
Vertical curves[13]						
K for determining safe length						
Crest vertical curves	80	50	50	28	50	28
Sag vertical curves	70	50	50	35	50	35
Minimum length, ft.	150	120	120	90	120	90

NOTES:
1. The symbol "T," with percentage limitations, represents the proportion of total traffic composed of buses, trucks, and track-laying vehicles; the remainder are light-delivery trucks and passenger cars.
2. The DHV is equal to approximately 12 percent of the ADT.
3. These values show the mixed traffic volume which requires the same operational area as that required by traffic composed of light-delivery trucks and passenger cars. These DHV's are based on the indicated percentage of the daily volume and may be overconservative in some instances because the percentages of trucks, track-laying vehicles, etc., during peak hours are generally considerably lower than the average percentage during all hours.
4. The traffic and parking lane widths indicated are for use on streets where the traffic will consist principally of vehicles with maximum overall widths of 8 ft or less. For determining traffic lane width for use of excessive-width vehicles, see paragraph 3-1.b. Traffic lanes of streets without curbs in warehouse areas should not be less than 12 ft regardless of class. The total width of streets with curbs adjacent to warehouses should not be less than 30 ft between curbs regardless of class. The values given for width of parking lanes is the distance between the outside edge of the adjacent traffic lane and the face of the curb for Type IV curbs. The width of gutter in combined curb and gutter (Types I and III curbs) may be included in the width of parking lane provided the gutter is as strong structurally as the adjoining pavement, otherwise the width of parking lane shown will be the distance between the outside edge of the adjacent traffic lane and the inside edge of the gutter.
5. See paragraph 3-2 for criteria relative to provision of parking facilities.
6. Distance shown is the minimum distance between face of curbs.
7. Where Class E streets are designed with barrier curbs, curb offsets are not required adjacent to traffic lanes.
8. Generally, barrier curbs will be provided on streets in built-up areas. See paragraph 3-2 for exceptions on provision of curbs within built-up areas at Army installations. Types I and IV curbs greater than 6 in. in height and Type III curbs greater than 18 in. in height are considered to be lateral obstructions. The curb offset is measured from the edge of the pavement to the vertical face of the curb or the curb portion of a combined curb and gutter.
9. Where traffic volume requires construction of multilane streets, opposing traffic should be separated by medians. Width and location of medians, median shoulders, and median curbs are discussed in paragraph 3-3.b. Generally, medians are provided with barrier curbs in built-up areas.

Table 1-2. Geometric Criteia for Classified Streets Within "Built-up" Areas of Army Installations
(Continued)

NOTES: (Continued)

10 There should be a color or textural contrast between pavement and shoulder surface sufficient to clearly define the pavement and shoulders in all types of weather.

11 Absolute maximum values shown were calculated on the basis of a maximum rate of superelevation of 0.02. Superelevation rate of 0.04 or 0.06 may be used on streets in which case the absolute maximum values for horizontal curves will have to be recalculated.

12 The term "critical length" is used to indicate the maximum length of a designated upgrade upon which a loaded truck can operate without an unreasonable reduction in speed. Methods for determination of critical length are discussed in paragraph 3-6.a.(1).

13 The minimum lengths of vertical curves are determined by multiplying "K" times the algebraic difference of grades (in percent).

14 On-street parking will not be provided on new Class B or C streets. Dimension given is applicable only to existing streets.

a The DHV is given in total vehicles per hour for all lanes in both directions.