Weighted averages used by Haile, adjusted for the number of units of a particular make registered, reveal trends in public buying preference. Similarly, the trends for the three most popular makes plotted by Nagler (see p.) show that the public has displayed a clear desire for the longer, lower, wider offerings. The popular makes have approached the extremes in dimension in order to remain popular, even, in several cases, to the extent of employing the identical body shell as their more expensive luxury line relations. People who own only one automobile must select a unit to accommodate their occasional maximum needs, rather than their average requirements.

The author is aware that the checks proposed for driveway profiles are stringent. They are intended to be suitable not only for the most popular vehicles of the present, but also for the more extreme vehicles of the present and future, under critical operating conditions. In designing automobiles, provision must be made for satisfactory performance under occasional extreme conditions as well as under average operation, just as highway designers build their bridges to support the heaviest anticipated load. No less stringent guide should be acceptable in highway geometrics.

It is not believed that public interest is served by setting minimum standards for new construction to meet only current average requirements. In the absence of better objectives, minimum standards tend to become standards. To protect the investment in facilities intended to be useful 20 to 50 years hence, it is unwise to adopt criteria which will not be suitable for the most extreme conditions which can now be foreseen.

II. Street and Highway Design

L. A. BAUER, Expressways Engineer, City of Cincinnati

● FOR THE past several years, the automobile industry has been changing their design of cars, by making them lower and longer. On most makes and models of cars the underclearance has been reduced and both the wheelbase and over-all lengths have been increased to such an extent, that sufficient underclearance is not being provided for a safe and satisfactory entrance into many of the driveways throughout the country. This is especially true in the City of Cincinnati and like communities where topography is rugged and many steep driveway entrances, either ascending or descending from the main roadway must be used to gain access to the abutting property.

This discussion will deal with experiences in the City of Cincinnati, which experiences, it is presumed, are prevalent in many other areas and communities similarly situated.

The problem of insufficient underclearance of cars entering or leaving driveway entrances exists primarily in the suburban or residential districts, principally on streets which were improved many years ago before the automobile age or, at least, prior to the advent of present day styled cars. Many of these streets have high-crowned macadam roadways, rather deep gutters and often walks are constructed at a considerable height above the curbs.

Figure 1 shows the dimensions of underclearances, wheelbase, overhangs and over-all length of the model car which will be used in the illustrations which follow. As can be noted, this is one of the largest of the cars made.

Figure 2 shows a typical driveway profile where a high-crowned roadway and deep gutters exist. As a car enters the driveway (position 1), the front bumper will often strike the driveway ramp between the walk and gutter. When the car reaches position 2, with back wheels in the gutter, the rear bumper usually strikes the street paving because of the high crown, and the center of the car will drag or scrape over the walk. Often further trouble is encountered wherever the driveway ascends or descends on a steep grade after crossing the sidewalk. This situation occurs quite frequently in suburban areas and is a source of many complaints from users of the driveways involved. Obviously the trouble can be corrected only through extensive walk and driveway re-

construction, pavement remodeling and raising of the gutter or a combination of all at considerable expense.

When a new street is made or an older street is reconstructed and repaved, the highway designing engineer must design the driveway entrances to meet the clearance requirements of the modern automobiles. Even in new construction, some trouble is very often encountered, in connecting existing driveways properly to the new improvement.

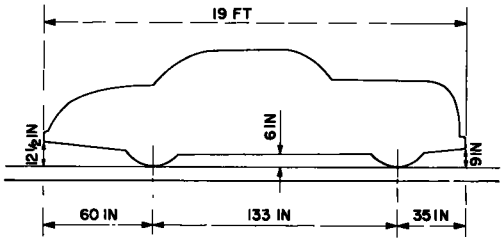

Figure 1.

The following discussion will deal with the construction methods for connecting driveways to new highway improvements worked out by the City of Cincinnati, which discussion will be appropriately illustrated.

There are two typical cases involved, one case where there is a ribbon walk some distance (say 8 ft) from the curb, and another case where the pedestrian walk is placed adjacent to the back of the curb.

In the first case, where the ribbon walk exists, two examples are being illustrated.

Figure 3 shows the ribbon walk type of construction with an ascending driveway.

Since there is a considerable distance between the curb and ribbon walk, little or

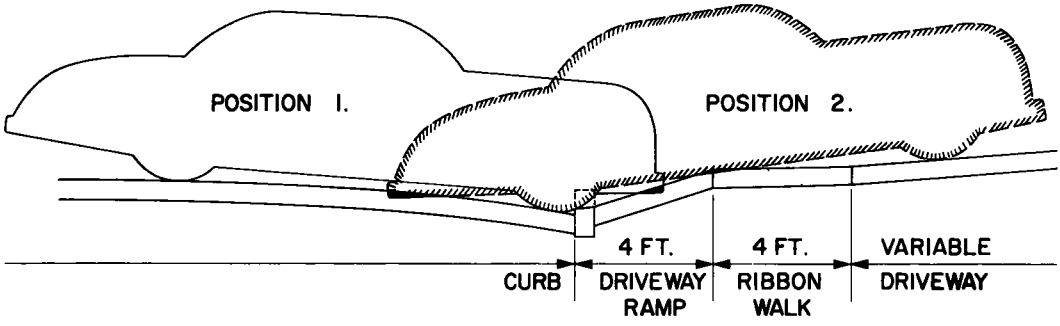

Figure 2.

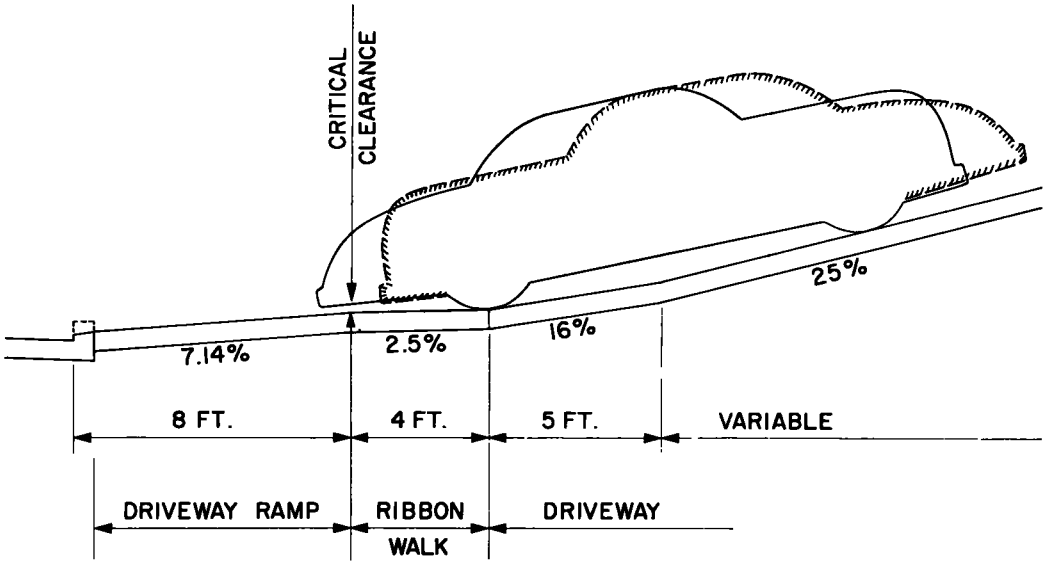

Figure 3.

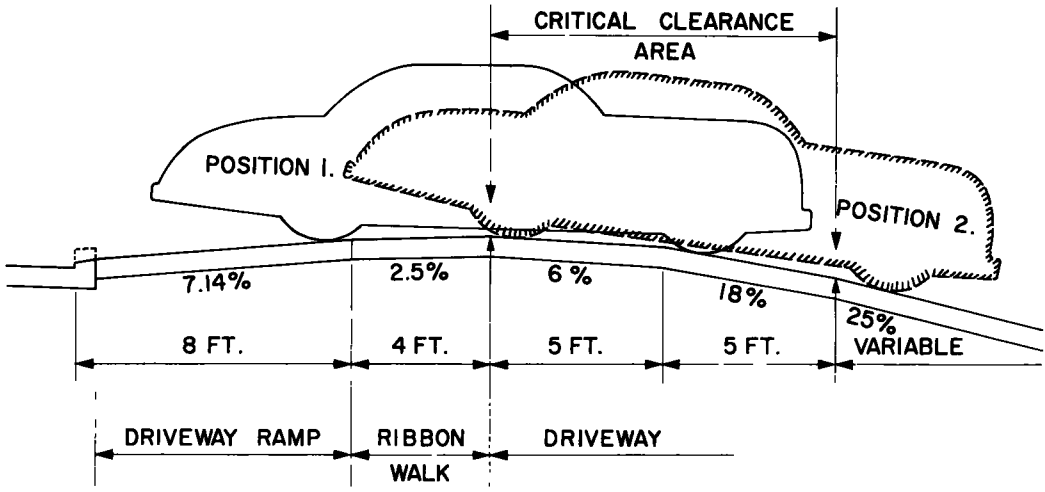

Figure 4.

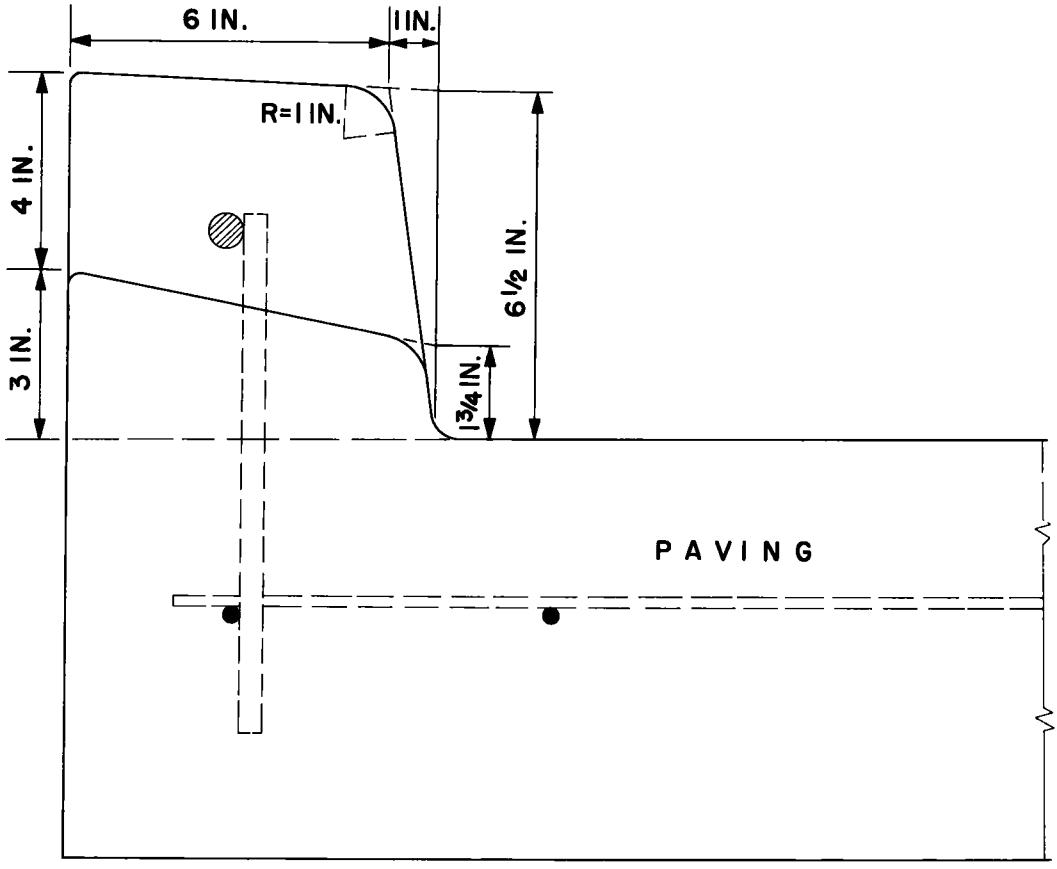

Figure 5. Standard concrete curb.

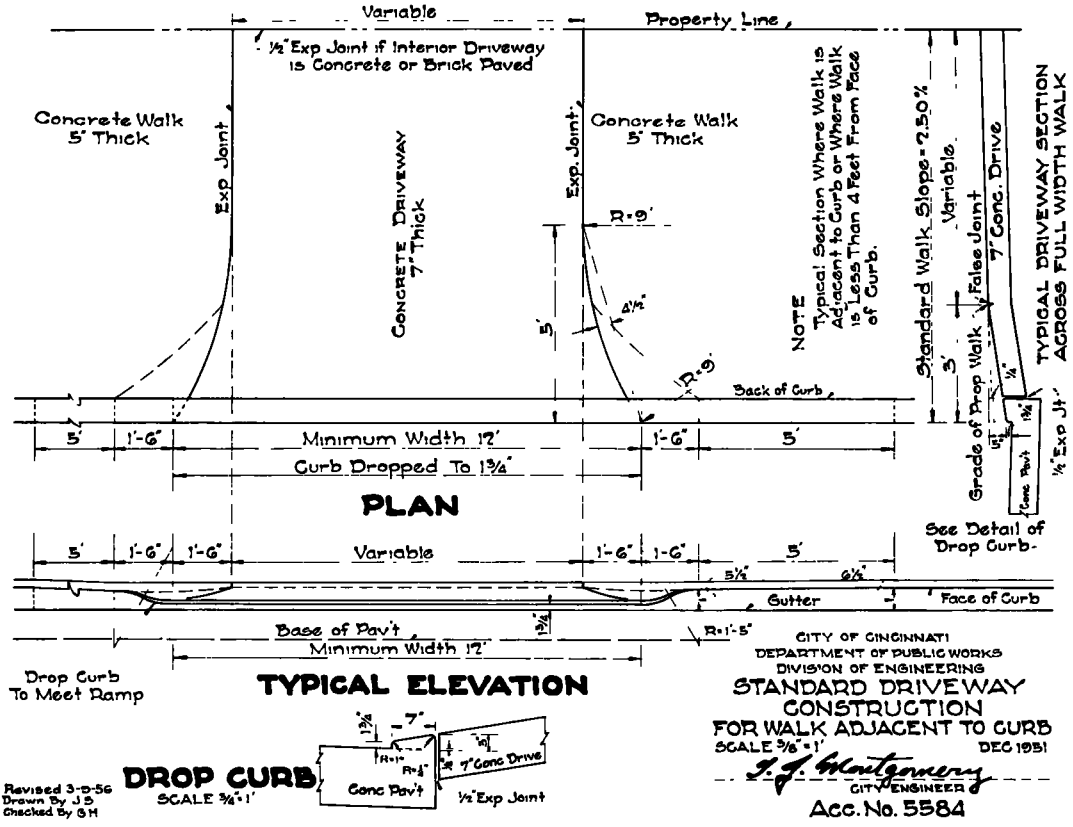

Figure 6.

no difficulties are encountered in this area, as this portion of the ramp (between curbline and walk) usually has a gentle grade. When the driveway ascends steeply from the back of the walk into the owner's property, the ascent for the first 5 ft back of the walk should not be more than 10 in., or at the rate of 16 percent, otherwise the car will be tilted too much before it crosses the walk and the bumper will strike the ribbon walk at the break in grade nearest to the street curb.

The 25 percent grade shown on the illustration is the maximum recommended grade for driveways on private property.

In the design of the driveway profile, care is taken to insure a 2-in. underclearance at all critical points for all makes of cars. This 2-in. clearance is used as a safety factor to take care of the downward thrust that cars take when traversing the varying profile grade of the driveway and when brakes are applied.

Figure 4 shows the same type of ribbon walk construction as in Figure 3, however in this profile a steep descending grade is shown. In this instance the clearance under the middle of the car is the controlling factor to be considered in the design. The maximum rate of descent from the back of the walk into the owners property should not be more than 6 percent for the first 5 ft and 18 percent for the next 5 ft, or a total drop of 1 ft and 2½ in. in the first 10 ft.

The second case to be considered is where the pedestrian walk on a street is placed adjacent to the back of the roadway curbing. This type of construction is frequently used in the City of Cincinnati, even in the outlying areas for the following reasons. Most of the existing right-of-way widths on important thoroughfares are either 50 ft or 60 ft. It is advantageous to avoid buying property along improved lots, in making new improvements on these streets. Therefore, 36-ft roadways often are constructed in the 50-ft right-of-ways and 44-ft roadways in the 60-ft right-of-ways. This leaves 7

or 8 ft of space from the curb line to the property line for sidewalk purposes, including space for poles and fire hydrants. Since this 7 or 8 ft wide space is rather narrow for both a ribbon walk and grass plot, a 6 or 7 ft wide walk is usually placed adjacent to the curb, or when a ribbon walk is used the street edge of the walk is not more than 3 ft from the curb face. Therefore, the maximum distance available for a driveway ramp from the gutter up to the walk grade is 3 ft.

In February 1942, the City of Cincinnati adopted a standard section of concrete curbing for all new concrete roadway improvements. This curb standard, designated

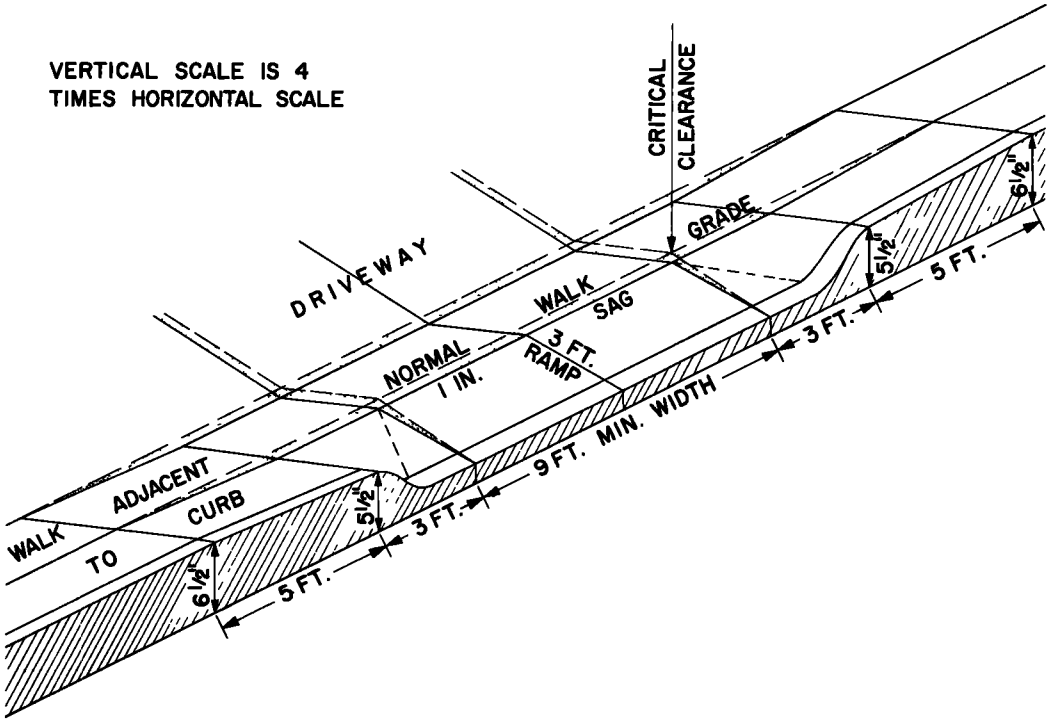

Figure 7.

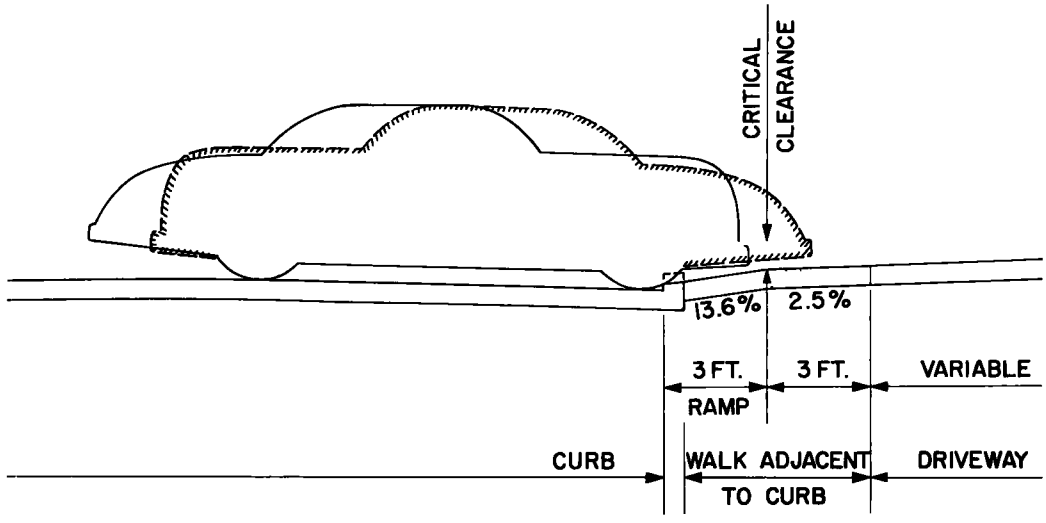

Figure 8.

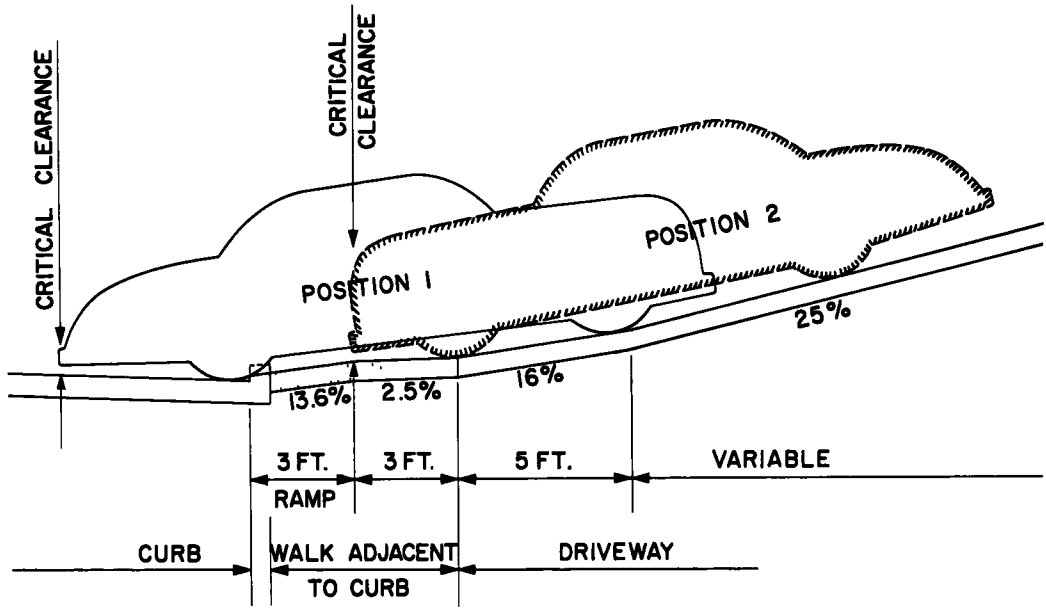

Figure 9.

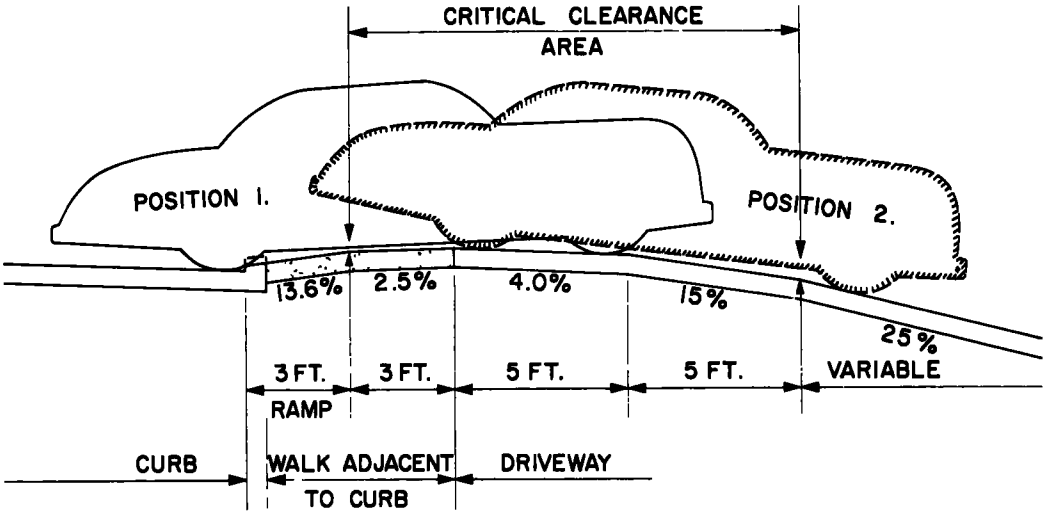

Figure 10.

as Figure 5, has a battered vertical face and a depth of 6½ in. from gutter to top of curb. The depth of more than 6 in. was designed for the purpose of permitting a future surfacing of the concrete pavement while still retaining a satisfactory gutter depth. This 6½-in. curb depth, plus an additional rise of about an inch across the 3 ft of walk space make a total rise of 7½ in. from gutter to sidewalk. The resultant driveway profile proved satisfactory for the older passenger cars, however, with the advent of the newer cars having longer overhangs, the city received complaints of bumper scraping at the top of the ramp 3 ft from the curb line. This forced the city in 1951 to adopt a new standard driveway design, designated as Figure 6. This design decreases the curb depth from 6½ in. to 5½ in. across the driveway and sags the walk grade a corresponding 1 in. This seems to have satisfactorily solved the problem up to the present time.

The reduced curb depth and sagged walk across the driveways is brought out more clearly in the projection shown in Figure 7.

The vertical scale in this projection is four times greater than the horizontal scale. The 1-in. sag in the walk grade across the driveway is made with an easy run-off and is not noticeable in the completed improvement.

Figure 8 shows a car entering and leaving a driveway, which is ramped through the walk adjacent to the curb in a distance of 3 ft, with the walk grade sagged 1 in. It can be noted that either the front or back bumper will clear the walk by 2 in. when the car is standing still. The car's bumpers will just clear the walk when its wheels are in the gutter, while entering or leaving the driveway.

Figure 9 shows the situation where the walk is adjacent to the curb and an ascending grade into the owner's property. Just as in Case 1, Figure 3, the rise from the back of walk into the owner's property should be not more than 16 percent for the first 5 ft or a rise of 10 in.

Figure 10 shows the same walk situation with a descending grade into the owner's property after crossing the walk. The descent should not be more than 2½ in. or 4 percent in the first 5 ft from the back edge of the walk and not more than 9 in. or 15 percent in the next 5 ft, making the maximum permissible descent about 1 ft in the first 10 ft.

In planning and working out proper grades for driveways so many different kinds of situations are encountered that the preparation of a set of standards that will cover all cases is almost an impossibility. In the foregoing examples an attempt has been made to cover the subject as completely as possible and the standards proposed can be applied in most cases. However, every driveway encountered presents a slightly different problem. Widths of sidewalk spaces, differences in elevation between roadway and walks, position and grades of the existing drives and other conditions all vary in different instances. In order to be assured of the proper driveway design in questionable cases, the following procedure is recommended.

1. Design the driveway profile as nearly as possible to available standards.
2. Plot the profile on a natural (2 ft to 1 in.) scale.
3. Prepare a cut out model car on the same scale as the profile (see Fig. 1 for dimensions).
4. Slide the cut out model along the profile for finding any trouble spots and adjust the profile where necessary.

This discourse has been on the matter of driveway profiles where they connect to the roadway and are carried across the walk area of the street. Some difficulties are also encountered in getting in and out of garages, especially where the grades are steep.

It is hoped that this discussion has brought out the salient difficulties facing the highway design engineers and the property owners themselves, caused by the reduction in underclearances in recent automobile designs.

It is strongly recommended that no further reduction of underclearance by made on cars by the manufacturers and if at all possible a minimum underclearance of 7 in. be adopted for all makes of cars.