PROPOSED DESIGN STANDARDS FOR INTERREGIONAL HIGHWAYS

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SYNOPSIS

In January 1944 "A Report of the National Interregional Highway Committee Outlining and Recommending a National System of Interregional Highways" was transmitted to the Congress by the President of the United States and has since been distributed as House Document No. 379. This committee, with the aid of a staff provided by the Public Roads Administration, made careful and extended studies of the subject, as summarized in the report. The committee recommended the designation and improvement to high standards of a national system of rural and urban highways totaling approximately 34,000 miles and interconnecting the principal geographic regions of the country. When fully improved this system will meet to optimum degree the needs of interregional and intercity highway transportation and will establish a transcontinental network of modern roads essential to the future economic welfare and defense of the Nation.

In the Federal-aid Highway Act of 1944 there are provisions for the designation of "A National System of Interstate Highways" and for the expansion of the Federal-aid highway system to include the whole of the Interstate or Interregional System, thus assuring the availability of Federal-aid to any State in its construction.

It is recommended in the Report on Interregional Highways that any construction or improvement of sections of highways on the system be to a suitable standard to safely and efficiently carry traffic of a volume, speed and weight estimated to be that which will exist 20 years after construction. To the extent feasible the development of a controlled access or freeway system is recommended. The committee proposed basic standards of roadway design and location, recognizing that agreement on such standards must be reached by all authorities likely to have a share in the responsibilities for construction.

This paper is an explanation of the main features of these proposed basic standards, presented in diagrammatic form in such detail as is necessary to make clear the ultimate product that is desired. These standards serve as a practical summary of research work on highway location and design standards during the past several years and as a concise indication of design controls that are necessary to secure a high type of highway facility.

Early in 1941 the President of the United States appointed the National Interregional Highway Committee to investigate the need for a limited system of national highways and the possibility that construction of such a system might provide productive employment for manpower and industrial capacity expected to be available in the post-war period. Thomas H. MacDonald, Commissioner, Public Roads Administration, was elected chairman of the committee and a small staff was supplied by Public Roads Administration through which the committee made careful and extended studies. The results of this research were submitted in a preliminary report in October 1941, and in a final report completed in January 1944. The latter, printed as House Document No. 379, 78th Congress, 2nd Session, is known as the Report on Interregional Highways. The system recommended by the Committee, in general following routes of existing Federal-aid highways, would, if fully improved, meet to optimum degree the needs of interregional and intercity highway transportation and provide a transcontinental network of modern roads essential to the future economic welfare and defense of the Nation.

In brief, the report recommended: (1) that Congress immediately provide for the designation of an interregional system, (2) that plans be developed for the post-war construction of the system to be designated to the highest modern standards, on locations and within rights-of-way where they will have the prospect of long and beneficial service, (3) that the initial mileage be limited to about 40,000 miles composed as nearly as practicable of those routes which, together with their urban connections, will serve a larger volume of traffic than any other larger or smaller network, (4) that since cities and metropolitan areas are the source and destination of a major part of all traffic, the proposed system of interregional highways, within the limit of mileage adopted, be located to connect as many as possible of the large urban centers regionally and interregionally, and (5) that since short-range movement is the predominant element of traffic on all roads, deviation be made from ideally direct lines of connection between the larger regional centers in order to connect enroute as many as practicable of the smaller urban centers of at least 10,000 population.

Thus, it was proposed that steps be taken to plan and develop a system of highways so constituted as to be national in scope, but so located as to render the maximum local service possible. The whole would be built as a modern express highway system, including portions to and through urban areas, embodying features of design and construction to provide, insofar as feasible, facilities capable of serving safely and efficiently a mixed traffic of automobiles, busses and trucks in the volumes, weights and speeds to be expected 20 years from the date of construction.

The Federal-Aid Highway Act of 1944 includes provisions for the designation of "A National System of Interstate Highways" and for the expansion of the Federal-aid highway system to include the whole of such a system. (The character and extent of the system to be designated agree identically with the recommendations of the Report on Interregional Highways; so that change in description from "Interregional" to "Interstate" is without significance.) With the passage of this Act in December 1944 the way has been cleared for the designation and beginning of work on the system. Other sections of the Act authorize substantial amounts for planning and post-war construction of highway projects on the Federal-aid system, in both rural and urban areas, as found necessary in the several States.

In order to define exactly the types and charcteristics of express highways recommended, the Report on Interregional Highways includes extended textual explanation of location and design features, and "proposed basic standards of road and structural design," applicable in rural and in urban areas. This paper is a discussion of the principal features of the Proposed Interregional Standards, which as a whole constitute a design specification for a high type of modern highway improvement. To the extent possible the design standards are shown as separate steps in a series of charts or diagrammatic illustrations. Complete reading of the report is recommended to cover points that cannot be treated herein, and for additional details that necessarily must be omitted in this presentation.

The development of an interregional, or interstate, system of highways requires a concerted attack by all branches of government, city, local, State and Federal. Close cooperation by all agencies can be obtained only if there is a complete understanding and agreement on the basic design features and standards. To the extent possible the proposed standards are flexible in recognition of topographic, regional and economic differences that inevitably exist in a country as vast as ours. The proposed standards are those deemed desirable in the light of extended research, experience and discussions with city, local and State officials and other authorities, to afford the design controls that are essential to secure the high type of highway facilities desirable on the Interstate System.

Figure 1—Properly to consider details of a national system of highways it is necessary to have in mind its local application. This map shows the recommended Interregional System as it fits the general topography of the United States. Note the portions of it that traverse your State, that serve your home, district, or approach your city. The system proper totals about 34,000 miles, of which about 4,500 miles are within the cities. In addition approximately 5,000 of alternate and auxiliary routes in cities will be needed.

Figure 2—This is the heart of the problem; the heaviest traffic volumes are in and near the cities, as shown by the vertical dimensions representing traffic flow on the recommended system. The system length is only 1 per cent of the total mileage of roads and streets in the United States, but adequately improved it would carry 20 per cent of the total travel. This illustration demonstrates why many of

the rural sections will need to have only two-lane surfaces, while sections in and near

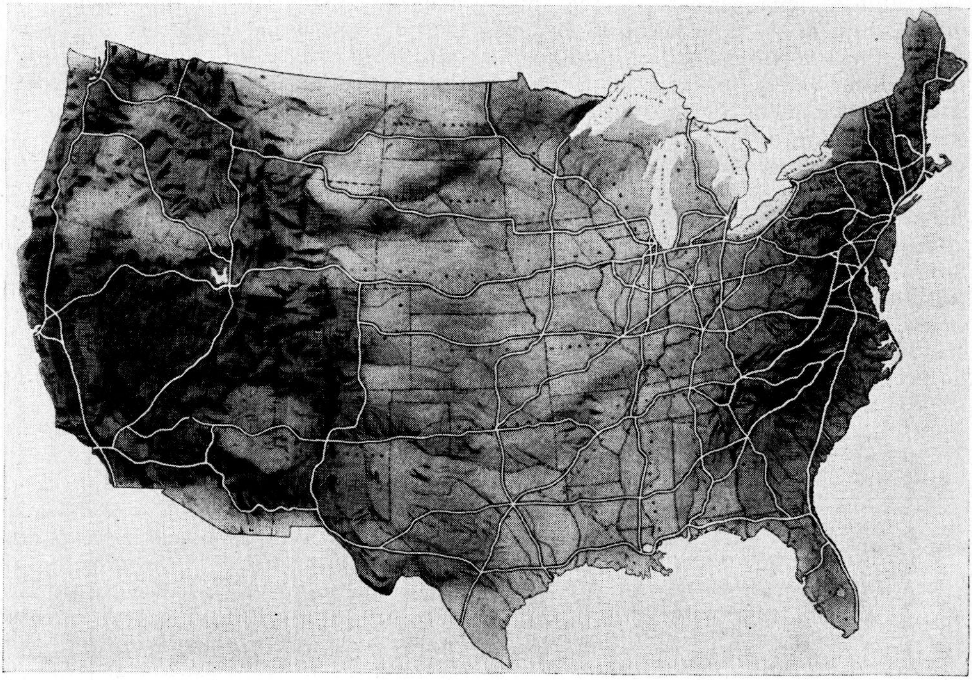


Figure 1. Proposed Interregional System

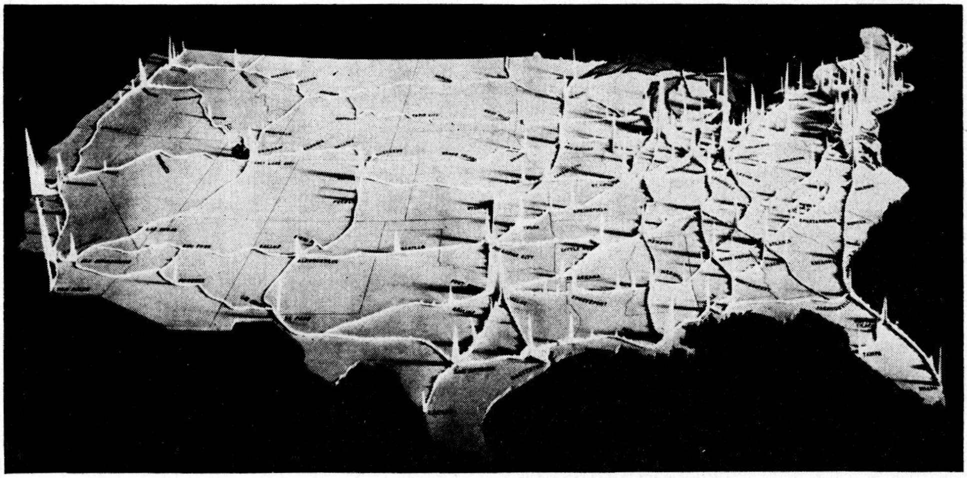


Figure 2. Traffic on Proposed System

the larger cities will require multi-lane surfaces.

The Interregional Committee recommends that "The Interregional Highway System shall provide or allow for the subsequent provision of facilities capable of serving safely and efficiently a mixed traffic of passenger automobiles, motor busses, and motor trucks, and tractor-trailer and semi-trailer combinations, of a volume of each of the constituent elements estimated to be that which will exist 20 years from the date of construction." The ultimate improvements on the Interregional System are to be adequate for both the type and volume of traffic, insofar as it can be estimated, that will need to be carried 20 years after initial construction. Thus all traffic data must be projected to estimates of future volumes to determine the essential ultimate facility to be provided. Initial construction may provide only the facility necessary to carry the present or immediate future volumes, but of course it should be patterned in such a way as to be a usable part of the ultimate improvement. Thus these standards serve to indicate the requirements for both present and future needs.

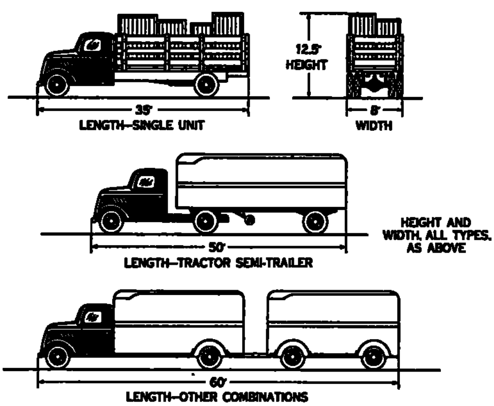


Figure 3. Maximum Vehicles to be Accommodated

Figure 3—This illustrates the maximum sizes of vehicles for which the highway facilities are to be designed, as recommended by the Interregional Highway Committee. All roadways and structures, the Committee suggests, should provide initially or in their feasible modification for vehicles of the sizes shown. Roadways and structures should be structurally adequate to support, in their expected distribution and frequency of passage, vehicles characterized by: (a) 18,000-lb. axle loads on pneumatic tires; and (b) gross weights according to a formula which gives a gross weight of about 36,000 lb. for a length between axles of 15 ft., 45,000 lb. for a 20-ft. length, or 52,500 lb. for a 30-ft. length, the length measured between front and rear axles of a single unit, or between any groups of axles of combination units.

It is intended, of course, that the system shall operate under the vehicular limitations imposed by the laws of the several States. The dimensions and weights shown, however, are those which are considered likely of ultimate uniform adoption for major highways.

Definition of Urban Sections: For purposes of design it is proposed to consider as urban all sections of the system passing through areas of city-like development, whether within or without the corporate limits of cities. All other sections of the system would be considered as rural, regardless of location within or without city limits.

The Committee recommends that "all sections of the Interregional System in or approaching a city or town at least 1 mile long, along which intersecting roads or streets average one-quarter mile or less apart, shall be considered as urban sections regardless of their location within or without the corporate limits of cities." This is a suggested differentiation between rural and urban sections for purpose of design of the highway facilities. Under the wording of the Federal-Aid Highway Act of 1944, which authorizes expenditures in urban areas, the boundaries of the urban areas are to be fixed by the respective State highway departments, subject to Public Roads approval. This distinction between urban and rural areas, made for the purpose of determining the availability of particular Federal funds, is not to be confused with the differentiation used for design purposes. Sections of the system may be classed as urban for purposes of design whether they fall within or without the urban areas to be delimited.

Figure 4—The Committee recommends that all rural sections of the system be designed at all points and in all respects for safe travel at the speeds shown by the height of the four bars at the left. The effect of topography is recognized, and controls are shown for the extremes of flat and mountainous topography. Intermediate speeds would apply for "rolling" topography. The corresponding speeds recommended for urban sections are shown by the height of the two bars at the right.

These bars indicate the design speed that should be "built in" the highway. However, it is expected that only the small percentage of faster traveling vehicles will operate at the design speed.

The "average running speed" indicated on the right of the chart is the speed that a driver can average over any section of considerable length at any time, except during a few peak traffic volume hours each year, without exceeding the design speed. It is not the average speed of all vehicles passing a single point on the highway. Passing sight distance restrictions, gradients, traffic volume, and number of lanes as well as the design speed affect this "average running speed."

Figure 5—These are the general width and structural requirements of the pavements and shoulders, as proposed. The upper sketch shows that the shoulders are to provide "lateral space and adequate support for standing or disabled vehicles, clear of the road surface or pavement." Likewise the pavements are to be "capable of supporting vehicles without reduction of either weight or speed at any season of the year." Shoulder surfaces are to contrast in color with the pavement surface.

The economic limitations are recognized in the shoulder requirements by a "wherever financially feasible" clause. In determining the type of pavement and shoulder, consideration must be given to the maintenance effort required to retain it in optimum condition.

Figure 6—A fundamental control in the design of the Interregional System is the control of access and elimination or control of cross traffic at grade to assure the safe and efficient use of the through road facilities. Insofar as possible, the Committee proposes that the system be built throughout as a controlled access system. In a strictly design sense this means that facilities for entrance to and exit from the through highway will be provided only at selected points where it is possible to develop connections of a type and extent consistent with the traffic requirements. Access facilities usually would be provided at grade separations of main cross roads or streets; intermediate crossroads or streets would be terminated or in some manner connected to the selected points of access.

This delineation pictures such treatment for a depressed interregional route within an urban area. Many of the cross streets are terminated at frontage roads on each side of the expressway. Selected major streets are carried over the expressway. High type one-way connections are provided between the through roadways and the frontage roads, located so as to utilize the grade separations.

As an expressway is followed out through the suburbs and into rural areas the access connections will be in general similar to these but of varying forms to fit the particular situations. There may be short sections of frontage road on one side only to serve housing nearby. Some minor outlying roads may be

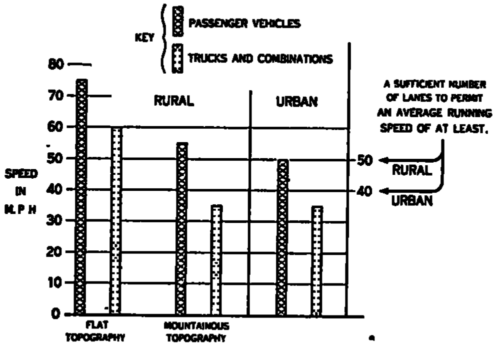
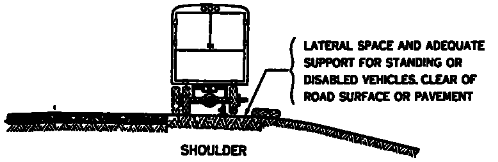


Figure 4. Speed Controls for Design



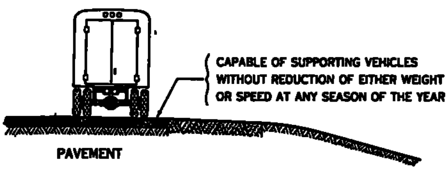


Figure 5. Shoulder and Pavement—Structural Design

terminated without connections to frontage roads, utilizing instead the closest existing roads. Or some similar roads may connect with facilities for only right-turn entrance and exit to the expressway. At the extreme case, in sparsely settled rural areas, where the Interregional route will be a 2-lane road, only the few major cross highways may be separated. Others will cross and connect with the interregional highway at grade, the type and extent of the connections depending on

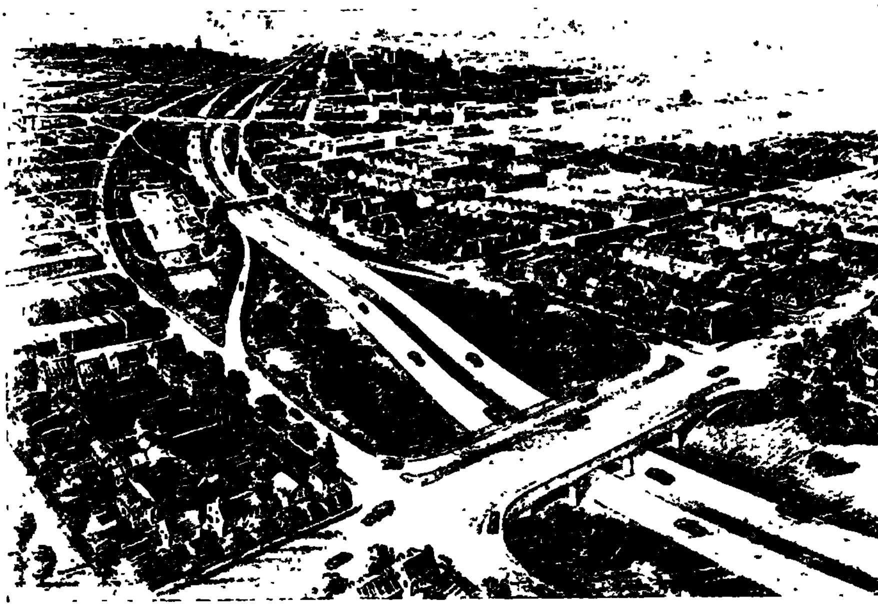


Figure 6. Depressed Urban Section

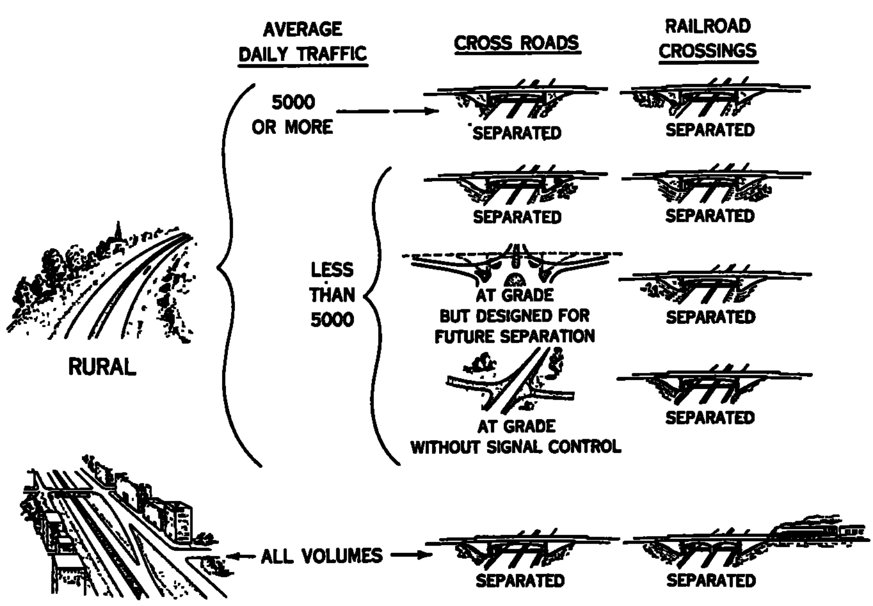


Figure 7. Intersections

the volumes of traffic. A basic principle of controlled access design is the reduction of the number of access and crossing points to a practicable minimum.

On lightly traveled sections in rural areas it will be neither feasible nor necessary to deny access to all abutting property. Access controls should be exercised to permit entrance to the through traffic lanes at such places and in such manner as it can be made with safety.

Figure 7—This chart illustrates the specific

requirements proposed for separation of railroads and crossroads or highways. The lower line shows the urban conditions and the upper four lines the several cases of rural conditions. In all cases railroad crossings will be separated, as indicated by the sketches at the right. Whenever feasible crossroads should be separated regardless of traffic volume. Mandatory separation is recommended in all urban areas and on rural sections with an average daily traffic exceeding 5,000. In any case initial construction to fit immediate traffic needs should include provisions, as necessary, for the ultimate construction to a higher type for the future expected traffic volume. Thus, on a section for immediate construction with an estimated daily traffic of 3,400 for 1945 and 5,600 for 1965, the

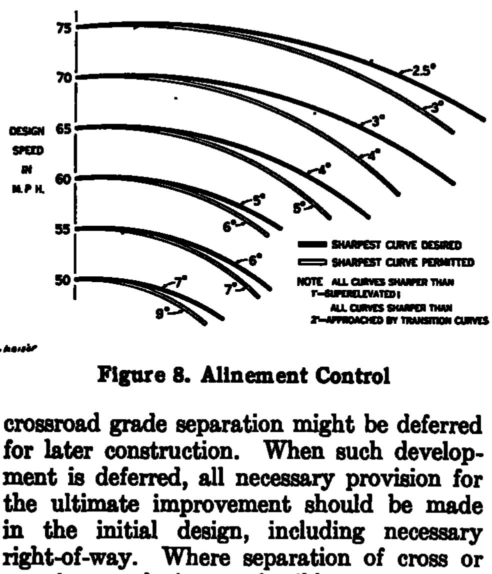


Figure 8. Alinement Control

crossroad grade separation might be deferred for later construction. When such development is deferred, all necessary provision for the ultimate improvement should be made in the initial design, including necessary right-of-way. Where separation of cross or entering roads is not feasible, as on some portions of 2-lane roads in sparsely settled areas, the design should be such as to insure a high degree of safety in crossing, entering or leaving the interregional highway, without use of traffic control signals.

On rural sections with daily traffic between 3,000 and 5,000 careful study will be necessary to conclude as to (a) an ultimate grade separation design, probably with a limited median width, or (b) an at-grade design with a wide median to protect crossing and turning vehicles, as will be shown later.

Figure 8—On all sections of the system it is recommended that the alinement be of as high a standard as feasible and the design speed as high as practicable, consistent with the topography and expected traffic volume. This chart shows the maximum curvature proposed for various design speeds. Preferred limits are shown by the solid lines, and the extreme values by the open lines. Note that the preferred limit would establish a curvature condition for each design speed equal to that established by the extreme limits for design speed 5 mph higher. For some conditions flatter curves than those shown may be necessary to provide desirable sight distance.

As indicated by the note, all curves sharper than one degree would be superelevated. On rural sections the maximum superelevation would be 0.12, or 0.08 ft. per foot where snow and ice may be expected. On urban sections the maximum would be 0.10. Superelevation would be attained gradually in such manner that the difference in slope between longitudinal profiles at the edges of a 12-ft. lane will not be greater than 1 in 200.

All curves sharper than 2 deg. would be approached by transition curves of sufficient length to meet speed requirements and to permit gradual attainment of full superelevation.

In use of these alinement controls the general location between control points should be as direct as feasible and should conform to the topography to avoid the appearance of forced alinement. On 4- or 6-lane sections the use of fixed cross section should be avoided. Instead, the Committee suggests that two distinct one-way roads should be provided wherever advantages of alinement, cost, or traffic facility may be expected.

Figure 9—Nonpassing sight distance is that required for the emergency stopping of a vehicle. Accordingly, the values shown here must be available, consistent with the design speeds, on all portions of the Interregional System. Nonpassing sight distance is measured, as shown at the top, from a height of 4.5 ft. above any point on the road surface (approximate height of driver's eye) to the top of an object 4 in. high placed on the road surface. The values shown apply over vertical curves at crests or horizontally across the inside of curves. It should be emphasized that the minimum sight distance

of 400 ft. may not provide safe stopping distance for many trucks and combinations traveling faster than 35 mph and 800 ft. may not be sufficient for such vehicles exceeding 50 mph.

Figure 10—This chart applies to 2-lane roads only. Passing sight distance is the length of road that must visibly be free of oncoming vehicles in order that the driver of a vehicle moving at the design speed can pass a slower moving vehicle. Such distances are

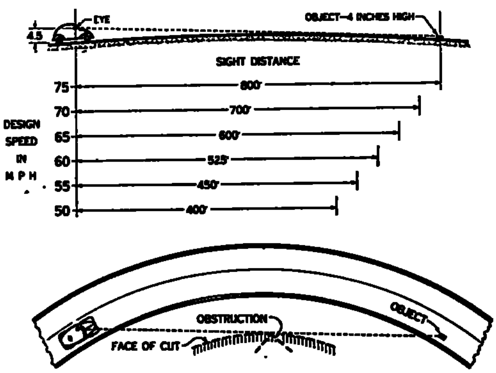


Figure 9. Minimum Nonpassing Sight Distance

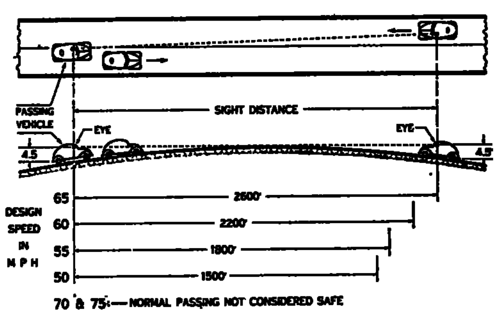


Figure 10. Minimum Passing Sight Distance—2-Lane Roads

measured between points 4.5 ft. above the road surface. A passing sight distance of 1,500 ft. is needed for a 50 mph design speed and 2,600 ft. for a 65 mph design speed. Passing at speeds above 65 mph on 2-lane roads generally cannot be considered safe inasmuch as the distances required are so long as to be beyond the perception-recognition distance of many drivers.

Provision of the indicated sight distances is admittedly difficult in rolling and rough topography. All 2-lane sections of the system, the Committee suggests, should be designed to provide at least these minimum sight distances wherever it is financially feasible to do so. The frequency with which safe passing sections can be provided is dependent upon several factors—type of topography, cost of construction, etc. Only in flat topography is it likely that there will be sections with continuous safe passing sight distances. Passing sections should be frequent enough to serve the intended purpose and the questions of cost and topography must be analyzed jointly with the expected traffic volumes and likely speeds of vehicles to assure that sections provided will permit a desirable facility for passing on 2-lane roads.

On 2-lane sections of the system where the daily traffic is expected to exceed 2,000 vehicles, and it is not feasible to provide these minimum

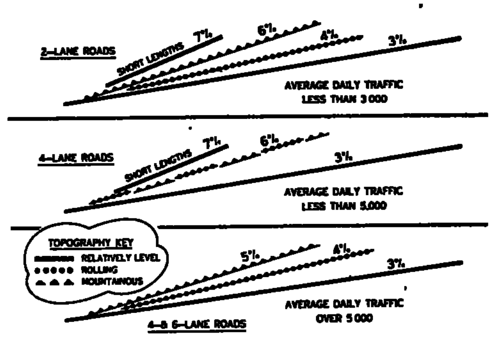


Figure 11. Maximum Gradients

passing sight distances where needed, a 4-lane highway can be provided instead. In many cases the desired capacity and utility of the highway can be obtained at less cost by use of four lanes than by the construction of 2-lane surfaces with the additional extensive work required to provide passing sight distances.

On 2-lane sections of the system with expected daily traffic less than 2,000 and where the provision of passing sight distance is not financially feasible, the longest practicable sight distance will be provided. Sections not safe for passing maneuvers will be appropriately and conspicuously marked as such.

Figure 11—The gradients on sections of the system are to be carefully determined for adaptation to the topography and the volume of traffic, particularly the proportion of trucks and tractor combinations, and the need for passing of such units on upgrades.

This chart shows the maximum gradient limits proposed for three traffic volume groups and, as shown by the key at the lower left, three general classes of topography. For daily traffic less than 5,000, on both 2-lane and 4-lane roads, the range limits are 3 and 6 per cent. On 2-lane roads a maximum gradient of 4 per cent is required for the intermediate or "rolling" topography in order to permit the maximum feasible speed of trucks and tractor combinations and correspondingly to reduce the frequency of passing. Four-lane divided highways permit ready passing of slow-moving trucks and tractor combinations in the number to be expected for volumes under 5,000, and accordingly a 6 per cent gradient can be used in rolling topography as well as in mountainous areas.

On sections to carry a daily traffic over 5,000 vehicles lower maximum gradients are required, 5 per cent for mountainous and 4 per cent for rolling topography. These limits are desirable because of the greater number of slow-moving trucks and tractor combinations to be expected and the consequent necessity to permit maximum feasible speeds of such vehicles to reduce the frequency of passing.

On very short grades and on one-way downgrades steeper gradients may be used, but not in excess of 7 per cent. In general, extremely long grades should be less steep than the values shown. These values should be used as an infrequent maximum rather than as a repeated control gradient. On sections carrying a large proportion of heavy commercial vehicles and where topography requires long grades steeper than 3 to 4 per cent (the grades at which loaded trucks reach or approach crawl speed on long ascents) it may be desirable to use gradients of 6 per cent instead of intermediate values, in order to reduce the length of grade. Because of the effect on passenger vehicles gradients of 7 per cent should be confined to short lengths.

On urban sections of the system gradients preferably should not exceed 3 per cent and in no case should they exceed 5 per cent, as shown for 4- and 6-lane roads.

Figure 12—Throughout the system the Committee's recommendation would require all lanes for through traffic to be 12 ft. wide. On rural sections, with daily traffic less than 2,000 vehicles, a 2-lane pavement would be provided. Where passing sight distance, as previously shown, can be obtained 2-lane facilities are deemed adequate to carry a daily traffic up to 3,000. Where the provision of minimum passing sight distance is not feasible on rural sections to carry between 2,000 and 3,000 daily traffic, a 4-lane divided highway is recommended. The median strip preferably should be 15 ft. wide, but in no case less than 4 ft. wide.

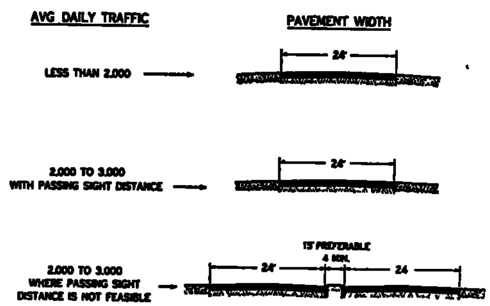


Figure 12. Pavement Widths—Rural

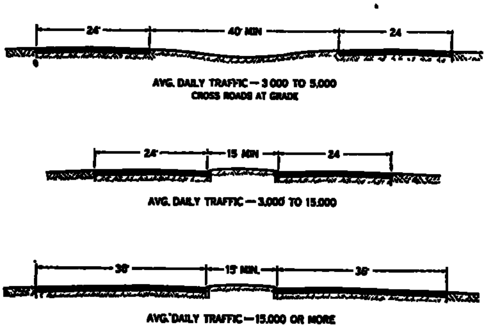


Figure 13. Pavement Widths—Rural

Figure 13—All rural sections of the system expected to carry a daily traffic of 3,000 or more would be divided highways, as shown here, if the Committee's recommendations are adopted. The top cross section shows the required median width of 40 ft. for crossroads at grade, which would be permitted where the daily traffic is less than 5,000. Such median width is deemed necessary at openings for protection of vehicles turning or crossing. Where similar designs are used at private property entrances, the median width would be at least 25 ft.

Between intersections and at all other places on sections for a daily traffic of 3,000 or more the median width would be at least 15 ft. as shown on the central cross section. Wider medians are desirable, particularly for night driving, but the essential separation of opposing rural traffic streams cannot be obtained with median width less than 15 ft. Whenever practicable the one-way pavements should be located and designed as separate but adjacent roadways, rather than to a fixed cross section.

Rural sections to carry a daily traffic of 15,000 or more would be designed as 6-lane part of this length would require widening to four lanes in lieu of passing sight distance provision.

The wider lines, both open and shaded, show the 26.2 per cent of the rural part of the system for which divided highways are required. Only 0.5 per cent carried traffic over 15,000, for which six lanes are needed. The shaded portions show existing improvements that are four lanes or more in width, the solid band being the undivided sections. These constitute 11.7 per cent of the rural

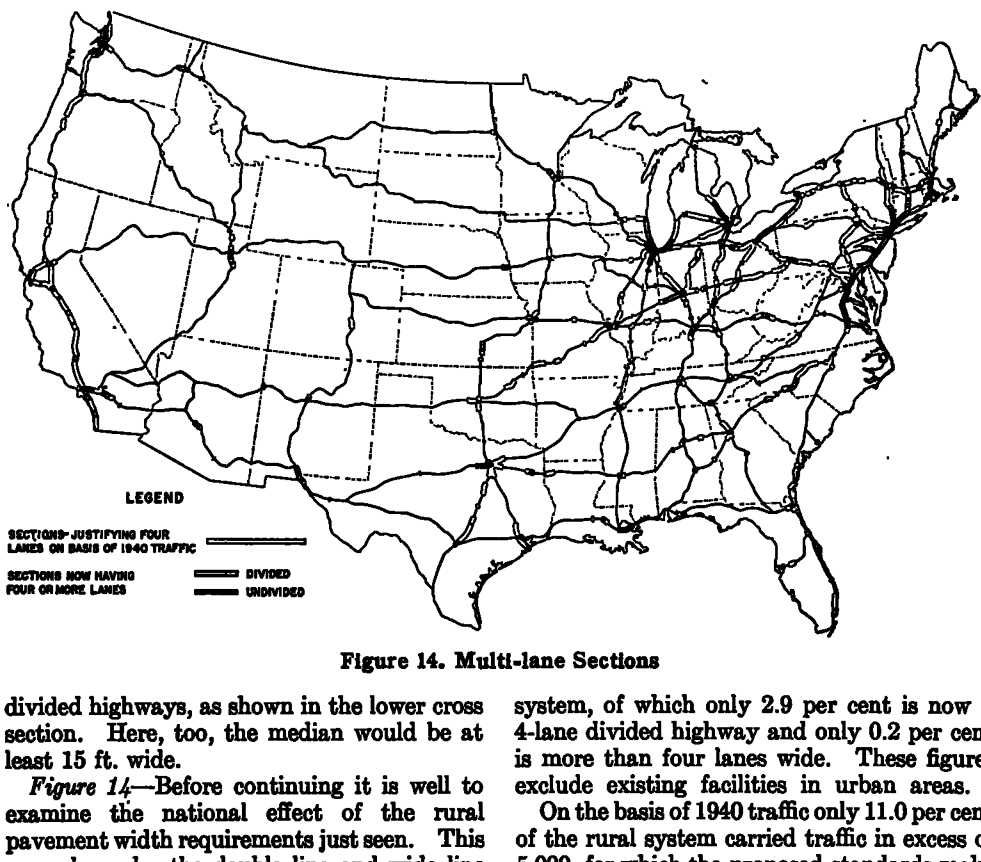


Figure 14. Multi-lane Sections

divided highways, as shown in the lower cross section. Here, too, the median would be at least 15 ft. wide.

Figure 14—Before continuing it is well to examine the national effect of the rural pavement width requirements just seen. This map shows by the double line and wide line symbols, the sections of the system that require divided 4-lane pavements on the basis of 1940 traffic flow. The single lines indicate the sections of the system with less than 3,000 daily traffic, where only a 2-lane facility would be required. These latter sections total 73.8 per cent of the 29,500 miles of the system in rural areas. An indefinite but probably small system, of which only 2.9 per cent is now a 4-lane divided highway and only 0.2 per cent is more than four lanes wide. These figures exclude existing facilities in urban areas.

On the basis of 1940 traffic only 11.0 per cent of the rural system carried traffic in excess of 5,000, for which the proposed standards make controlled access design mandatory. If we assume that as a whole traffic expected in 20 years will show an increase of two-thirds above that of 1940, then about 26 per cent of the rural system would need to be of full controlled access design and about 50 per cent would require divided highway section in 1960. Such estimates show that these standards do not envisage the impractical construction of transcontinental superhighways, but are rather the practical and essential answer to traffic conditions likely to be reached within our generation.

Figure 15—The urban sections of the sytem total approximately 4,500 miles, or 13 per cent of the entire arterial system. However, the report suggests that allowance should be made for the addition of up to 5,000 miles for alternate and auxiliary routes that may be required in urban areas. All urban sections would be designed as controlled access highways in their ultimate development, with separations of all railroads and crossroads or streets. As shown here sections for an expected daily traffic less than 20,000 would be built four lanes wide; those for traffic over

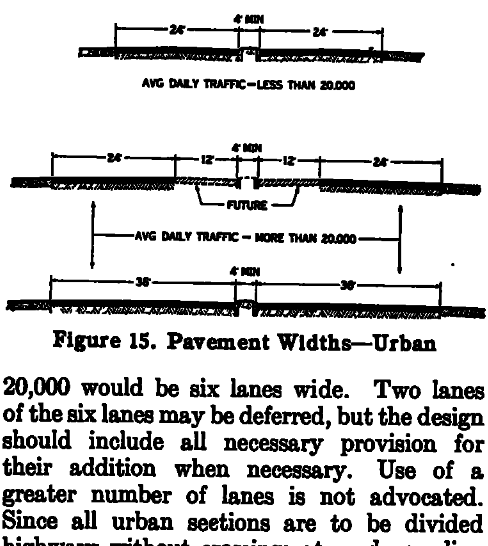


Figure 15. Pavement Widths—Urban

20,000 would be six lanes wide. Two lanes of the six lanes may be deferred, but the design should include all necessary provision for their addition when necessary. Use of a greater number of lanes is not advocated. Since all urban seetions are to be divided highways without crossings at grade, median widths narrower than those required for rural sections can be considered. Medians wider than the 4-ft. minimum suggested should be provided wherever feasible.

Figure 16—Shoulder width as shown here is measured from the outer edge of the pavement to the beginning of rounding, as in the top section, or to the face of guard rail, as in the central section. Continuous shoulders, on the right in the direction of travel, would be provided throughout the system except across long bridges. Shoulders would be 10 ft. wide, except in mountainous topography where, because of expense, such width is not feasible. For these exceptions the minimum width of shoulder suggested is 4 ft.

All shoulders would contrast in texture and preferably also in color with the expressway surface or pavement. Such contrast is to be carried across short structures and culverts. As previously shown, all shoulders are to be structurally suitable for infrequent or emergency use by vehicles of the maximum loads and at the maximum speeds expected.

In general all slopes would be flattened and rounded to the extent practicable within the limits for drainage, and the control slopes modified as deemed desirable to meet landscape requirements. On fills of 10 ft. or less, as in the top section, the side slopes would be not steeper than 4 to 1. In the central section,

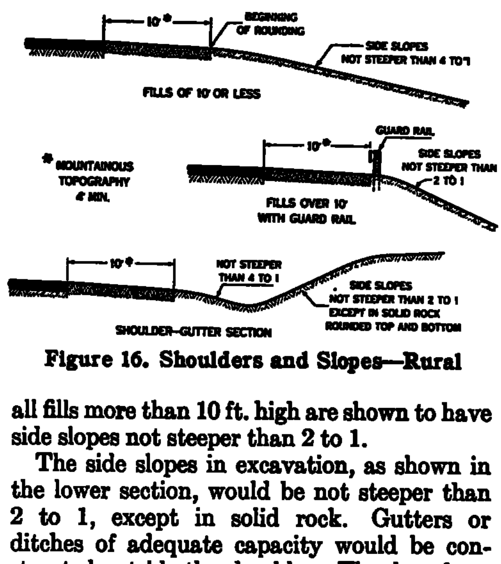


Figure 16. Shoulders and Slopes—Rural

all fills more than 10 ft. high are shown to have side slopes not steeper than 2 to 1.

The side slopes in excavation, as shown in the lower section, would be not steeper than 2 to 1, except in solid rock. Gutters or ditches of adequate capacity would be constructed outside the shoulder. The slope from the edge of shoulder would be not steeper than 4 to 1.

Figure 17—Sides of all excavations would be rounded at the top and bottom to merge by curves of natural appearance into the slopes of the adjoining land and those of the gutter or ditch. At the ends of cut sections the side slopes would be flattened as the depth of excavation decreases.

Figure 18—The general slope requirements for urban sections of the system would be the same as those for rural sections, with governing slopes of 2 to 1 and 4 to 1. However, emphasis is directed toward preferable slopes

of 4 to 1 on the sides of depressed highway sections.

Likewise the general requirements of width and stability of shoulder would be retained through urban areas, as shown in the upper section. However, provision is made for a shoulder equivalent outside a continous mountable curb at the outer edge of the pavement. This general design, termed a "standing area," is to be constructed to the required stability, and to the extent feasible,

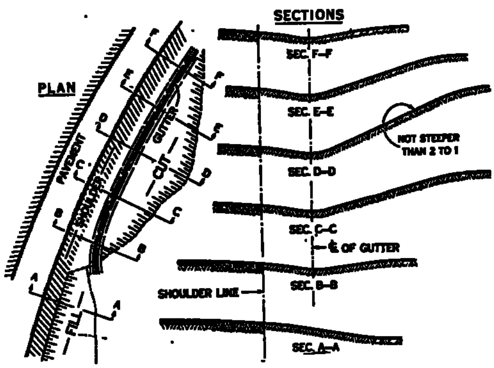


Figure 17. Warped Slopes—Fill to Cut

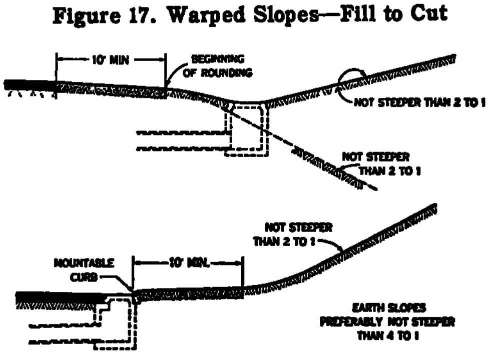


Figure 18. Shoulders and Slopes—Urban

to the full 10-foot width. It is in these sections with heavy traffic flow that a usable shoulder space provides the greatest benefits and accordingly a full shoulder is advocated throughout.

In urban areas underground drainage systems would be constructed for the removal of drainage from all pavements, medians, shoulders, and adjacent slopes. As schematically indicated in these sections, drop inlets of suitable hydraulic design and location would be provided in such manner as to avoid all possible hazard to traffic and reduction of traffic capacity of the pavements. A major difference of the urban from the rural sections, will be the curbs required for such drainage systems.

Figure 19—This figure shows suggested control dimensions for complete urban sections, which include frontage roads wherever necessary. The letter 'P' indicates the pavement 24 or 36 ft. wide, as traffic volume requires. Median strips are curbed and at least 4 ft. wide. Shoulders or standing areas are 10 ft. wide wherever possible. Frontage roads would be located at least at shoulder width and preferably at least 15 ft. from the edge of through pavement. They would be separated from the slopes or border areas by the inclusion of nonmountable curbs along the frontage road. Frontage roads generally would be

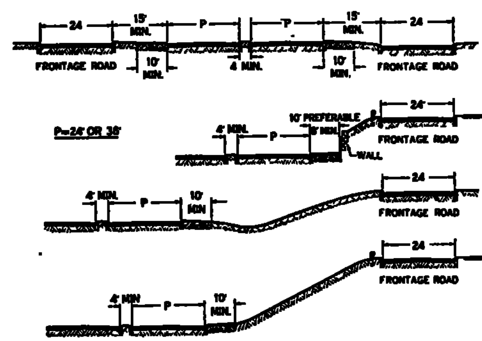


Figure 19. Cross Sections—Urban with Frontage Roads

designed as one-way streets in order to facilitate connections to the through highway. The 24-ft. width shown is a recommended minimum.

In urban areas, whenever it is necessary to elevate or depress sections of the interregional highway of substantial continuous length, a depressed section is in general preferred to an elevated section. Where elevation of the highway is essential it preferably would be accomplished by means of a structure of adequate and pleasing design. The lower three parts of this figure show types of slope treatment between frontage roads and a depressed expressway. Where lateral space is not available for desired slopes between the expressway and the frontage road, retaining walls would be constructed, as in the second section from the top. The face of such walls preferably would be at least 10 ft., and in no case less than 8 ft. from the edge of the through pavement. However, it would be necessary to place such walls only 4 ft. outside additional lanes or ramps.

The lower two parts of the figure show the same general slope sections as on the previous chart, one with a normal shoulder and swale or gutter for drainage, and the other with a curbed standing area.

Figure 20—The right-of-way widths shown here are those recommended for rural sections of the system. These standards call for the acquisition by purchase or by condemnation of sufficient right-of-way for all construction—roadway and slopes—as it may ultimately be developed. In addition, it is proposed that

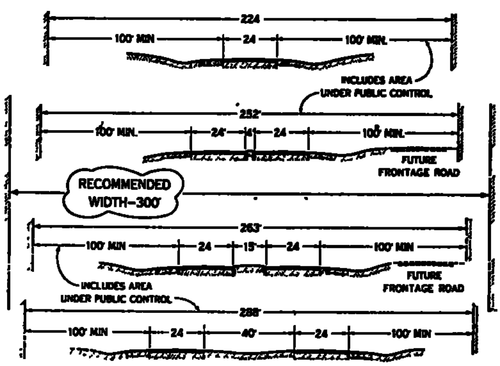


Figure 20. Right-of-Way Widths

public control be obtained over a strip of land to a width not less than 100 ft. outside the edge of the through traffic pavement. Such width is deemed necessary for the control of access, the landscape development, and the elimination of unsightly or distractive development, signs, etc., along the highway. Reading from the top down, these controls require rights-of-way 224 ft. wide for 2-lane pavements, and 252, 263 or 288 ft. for divided 4-lane pavements.

It is recommended that wherever feasible on rural sections of the system public control be obtained initially over a strip of land 300 ft. wide, regardless of the traffic volume to be handled. However, the right-of-way obtained should be sufficient in any case to include such frontage roads as may be necessary.

In urban areas sufficient right-of-way would be acquired for the construction of all parts of the expressway, necessary connections, barrier strips and frontage roads. Such right-of-way would be acquired in its entirety by outright purchase or condemnation as needed for the planned ultimate development.

General Requirements for Bridges

Wherever feasible, all bridges are to be located to fit the over-all alinement and gradient of the highway and are to be subordinated thereto.

All bridges constructed on the system are to be of steel or reinforced concrete. They are to be designed for the H 20—S 16 standard design loadings of the A.A.S.H.O. Lower loading standards may apply for bridges to carry crossroads or streets over the interregional highway, subject to local requirements, but in no case are designs to be made for less than H-15 loading on rural sections and H-20 loading on urban sections.

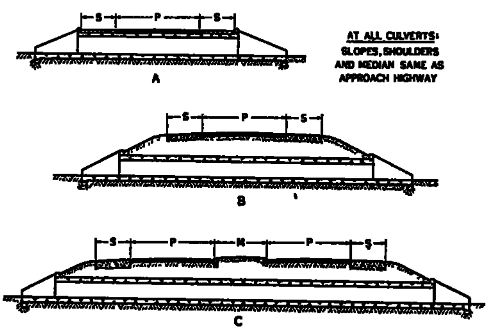


Figure 21. Culverts

Bridges of a length between abutments of 100 ft. or less are classed as short bridges. Those of a length over 100 ft. are classed as long bridges. Note these distinctions, as they are significant in the following details.

All short bridges are to be of deck construction. Long bridges preferably are to be of deck construction.

On all bridges the clear height over the entire width between outer curbs is to be at least 14 ft.

Pavements across bridges or through underpasses are to be a continuation of those on the approach highway. The portions of bridge pavements outside the width of the approach highway pavement are to approximate the color of the shoulders on the approach highway.

Figure 21—Structures of a length between abutments of 20 ft. or less are classed as culverts.

All culverts are to be constructed of steel, reinforced concrete or stone masonry, or pipes composed of material of corresponding

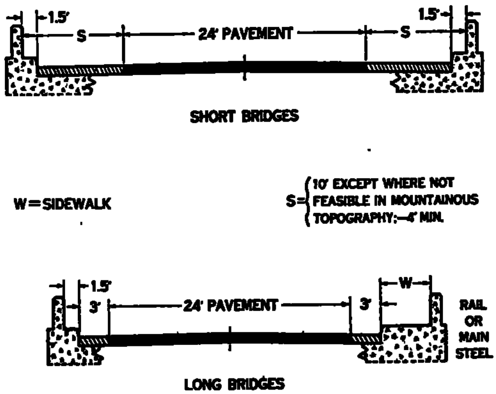


Figure 22. Rural Bridges—2-Lane Roads

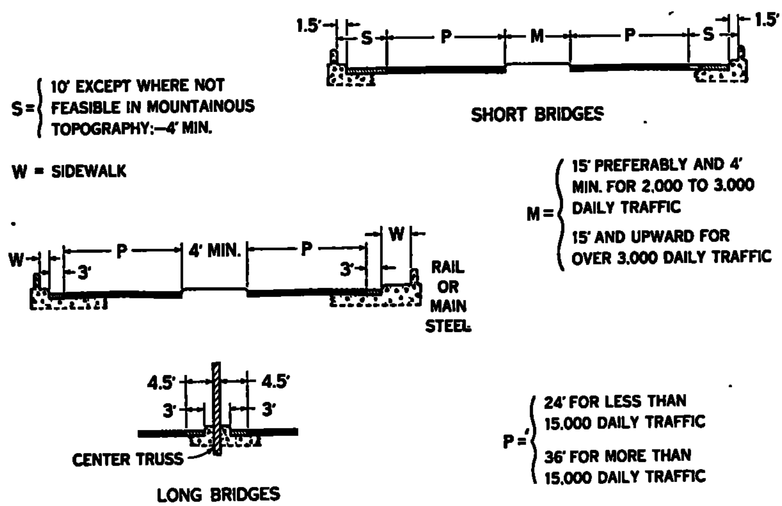


Figure 23. Single Structures—4-and-6-Lane Roads—Rural

durability. Culverts are to be designed to carry the H 20—S 16 loading plus the effective weight of fill material, where necessary.

The clear width of all culverts is to be sufficient to carry the pavements, median strip and shoulders across without reduction, and as necessary the continued slope outside the shoulders. For conditions as in Section 'A' the pavement over the culvert is to be identical with that on the approach highway and the paved portion corresponding to the shoulders is to approximate their color. Section 'B' shows the continuation of pavement, shoulders and slopes across the culvert in a form identical with that of the approach highway. The same is to be done on divided highways, as shown by Section 'C'.

The same standards apply for culverts in urban areas, except that a standing area used in lieu of a shoulder would be carried over without change.

Figure 22—On this and the following figures, for diagrammatic purposes, the through pavement is shown as a solid shaded area, the curb offset or shoulder space as diagonally hatched areas and the rail-walk sections by the concrete symbol. On any structure an open rail section would be desirable, and the diagrammatic rail-post section should not be construed as a suggested solid rail. Common dimensions are shown by letter definitions.

On all short bridges the distance from edge of pavement to the face of bridge rail, the letter 'S' in the upper section, would be not less than the width of shoulder, 10 feet in most cases. The distance from the face of curb to the face of rail or any structural member is to be at least 1.5 ft., and as much more as is necessary for walk space. Walk space is to be provided on all long bridges, but the general prohibition of pedestrian use of the shoulders will eliminate need for walk space greater than 1.5 ft. on short bridges.

On any bridge on rural sections of the system the distance from edge of pavement to the face of the vehicular curb is to be at least 3 ft., as shown here for long bridges.

Figure 23—On rural divided highways some of the bridges will be single structures, as shown here. On short bridges the median width of the approach highway is to be carried across without narrowing; wherever feasible the same is to be done on long bridges and at underpasses. At long bridges and underpasses where the median strip is reduced in width, the change in alinement is to be such as to avoid hazard and distorted appearance. Any such median at a structure is to be at least 4 ft. wide, with mountable curbs. The median widths, 'M', and pavement widths 'P' are the same as previously shown for the different daily traffic volumes expected.

The upper right section shows the median and shoulder widths carried across short bridges. The lower long-bridge section shows only the 3-ft. lateral offset for curbs. With a center truss the offset of 3 ft. and minimum walk space of 1.5 ft. require a 4.5-ft. clearance of the structural member from the pavement edge.

Figure 24—In other cases on rural divided highways two separate structures may be used as shown here. The details are the same as in Figure 23, except for the central or left rail section with the 3 + 1.5-ft. lateral clearance. With two structures a walk probably would be needed on both parts of long bridges.

Figure 25—The clear width of all underpasses would be sufficient for the pavement, median strip, and shoulders, as on the approach highway. The shoulder, median and pavement widths, the lettered dimensions 'S', 'M' and 'P', are the same as previously shown for bridges. Where 2-span undercrossings are used the face of the center pier is to be 4.5 ft. from the edge of through pavement, with 3-ft. offset to a nonmountable curb and curb width of 1.5 ft. For this condition a minimum median width would be about 11 ft. or more as the pier thickness itself might be increased.

Underpasses on curves would be widened on the inside as necessary to obtain the desired sight distance through the structure. The length of underpass would be sufficient to provide ample bridge width to accommodate the crossing railway or public highway. For public highways, bridge widths would be determined in the same manner as previously shown for bridges on the interregional highway.

A clear height of at least 14 ft. would be provided above the entire paved width. Clear height of at least 12.5 ft. would be available above the outer edge of the shoulders.

Figure 26—In urban areas the requirements for bridges are the same as for rural areas, except that the lateral clearance between edge of pavement and face of nonmountable

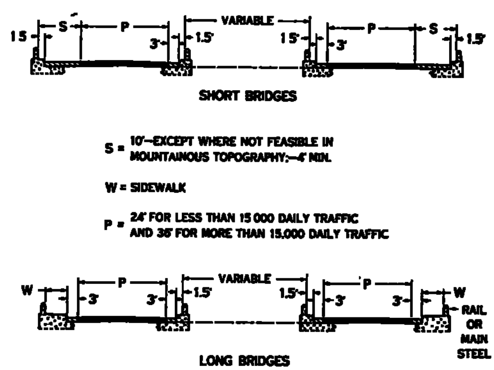


Figure 24. Two Structures—4- and 6-Lane Roads—Rural

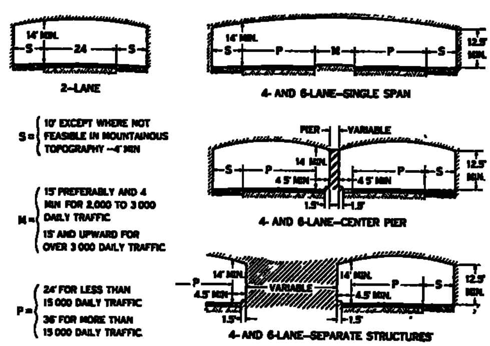


Figure 25. Underpasses—Rural

curb is 2 instead of 3 ft. Shoulders or standing areas 10 ft. wide and full width of median are advocated for all short bridges in urban areas. All urban sections of the system would be divided by median strips at least 4 ft. wide. The traffic requirement for a 6-lane section is based on a 20,000-vehicle average daily flow. Double structures also might be used, with the same controls as previously shown for rural sections.

Figure 27—Underpasses on urban sections

of the system, as recommended, are much the same as for rural sections. Narrower medians are permitted, and where continuous walls are used the shoulder width would be at least 8 ft. However, the reduction from 3 to 2 ft. in lateral clearance to curb does not apply at the left, or center pier condition. A minimum total clearance of 4.5 ft. is deemed

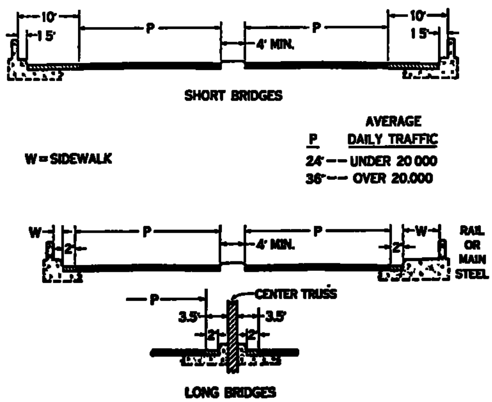


Figure 26. Bridges—Urban

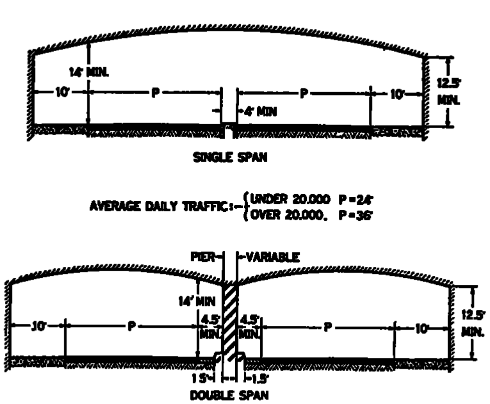


Figure 27. Underpasses—Urban

necessary because of the higher speed of traffic in the left lane.

Figure 28—On all long bridges walk space, of width as necessary, would be provided. However, on all rural sections of the system pedestrian use of the roadway, including shoulders, would be prohibited. Whenever feasible the same would be done in urban areas. The upper sketch at the right shows the 2- or 3-ft. offset to curbs separating walks on deck structures and an overhung sidewalk on through structures. When walks are necessary over short bridges or through underpasses the separating curb would be offset 8.5 ft., as in the left sketch, to provide the required shoulder.

Adequate pedestrian paths would be provided whenever the need justifies. Adequate walks outside the vehicular curbs would be provided for all cross streets or highways in urban sections, and wherever necessary at crossroads on rural sections of the system.

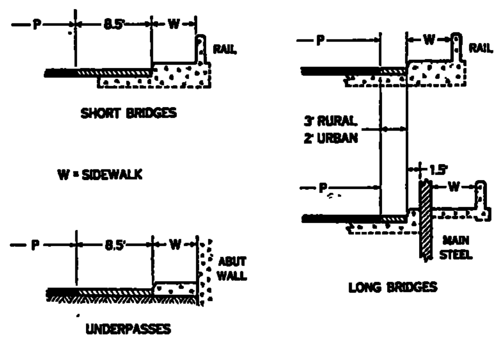


Figure 28. Structures with Walks

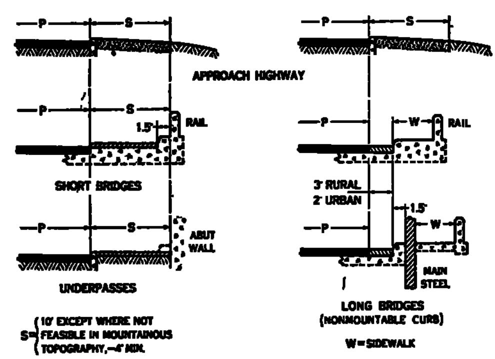


Figure 29. Mountable Curbs Continuous from Approaches

Walks found necessary along shoulders in urban areas would be separated from the edge of pavement by a curb and a strip at least 6 ft. wide. Where the need exists special pedestrian underpasses or overpasses with connecting walkways would be provided.

On rural sections of the system fences of adequate design would be erected wherever necessary, within or at the limits of the right-of-way.

Figure 29—Mountable curbs on the edge of highways approaching structures would be continued over short bridges or through

underpasses without change in either lateral position or vertical dimension. Where necessary, nonmountable curbs would be introduced in the same manner and at the same lateral offset as if there were no continuous curbs. As shown here, at the left, the shoulder width over short bridges and through underpasses would be a raised section at the height of the continuous mountable curb. However, on long bridges it usually would be desirable to swing over gradually the mountable curb on the approaches and at the same time transition the curb vertically into the nonmountable curb on the structure, with flush surface offset as previously described.

Figure 30—Curbs delineating median strips would be carried through or over structures without change in position or height. In these sketches the letter 'M' is the median width as required for the traffic volume classifications previously shown. Reading down at the left the three sections show continuous mountable median curbs. The upper section shows the same treatment over short bridges and through single-span underpasses as on the approach highway. The central section shows the same treatment with a center pier where the median width is large enough. The lower left section shows that a minimum width at double-span underpasses is 9 ft. plus the pier dimension. The treatment of median surface between curbs in these three sketches would be that deemed best, turfed or paved, for the width involved.

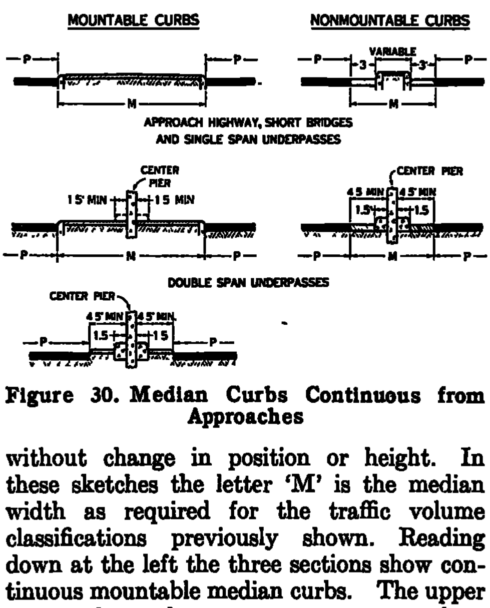


Figure 30. Median Curbs Continuous from Approaches

The two sections at the right show nonmountable median curbs continued over or through structures without change in lateral position. These would be offset at least 3 ft. from the left edge of the through pavement.

Where narrowing or widening of the median strip is necessary, as at long bridges or underpasses, the essential pavement and curb alinement changes would be effected over a length sufficient to avoid hazard in vehicular operation at the design speed and to avoid the appearance of distorted or forced alinement.

Figure 31.—Added pavement width, in the form of a taper or a full auxiliary lane, would be provided at all ramps and connections to and from the expressway. Parts of such auxiliary lanes may extend over or under structures. At a grade separation with inner loops on each side of the structure for exit from and entrance to the same through lanes, an added lane would be carried over the bridge or through the underpass to connect both inner loops. For such conditions somewhat smaller lateral clearances are permissible. The auxiliary pavement width—the letter 'A' as shown here—would be at least 3 ft. on rural sections of the system or at least 2 ft. on urban sections before the indicated values apply; a full lane would be at least 10 ft. wide.

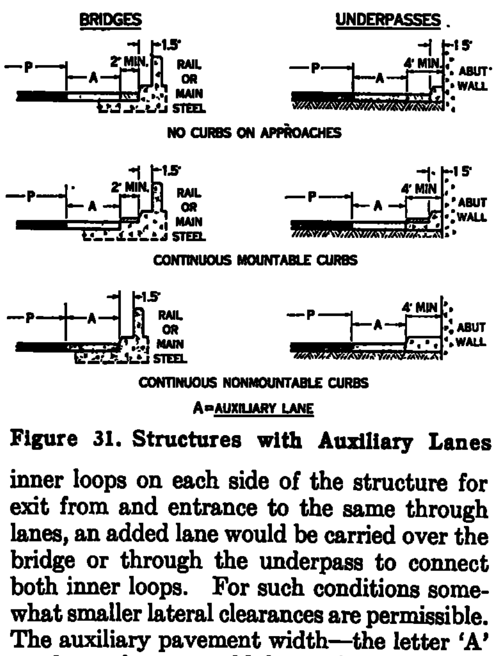


Figure 31. Structures with Auxiliary Lanes

At underpasses a 4-ft. lateral clearance from the outer edge of the auxiliary lane or width to the face of abutment would be required regardless of curb treatment, as shown in the three sketches at the right.

As shown in the upper left sketch when there are no curbs on the approach highway a nonmountable curb introduced at the bridge would be offset 2 ft. from the auxiliary lane width. As in the second left sketch a mountable curb on the edge of the auxiliary width would be continued without change over the structure. A nonmountable curb introduced at the structure likewise would be offset 2 ft. However, if a nonmountable curb is used on the approach highway it would be continued without change over the structure, or through an underpass. As previously shown for median curbs, on the approach highway such nonmountable curbs would be offset from the edge of pavement.

Figure 32—To the extent feasible any tunnels that may be required would accommodate the same number and width of traffic lanes as the approach highway. Tunnels on 2-lane highways would provide space for a 2-ft. flush median between lanes and a clearance of at least 4 ft. on each side.

On divided highways any single bore tunnels that are built would provide space for a 4-ft. raised but mountable median strip and at least a 4-ft. side clearance. In the case of twin bores the same clearance would be provided at the sides.

The clear height across the width of pavement would be at least 14 ft. Standards for gradients and curvature of tunnels would be the same as elsewhere on the system. All tunnels would be lighted and artificially ventilated as necessary to provide amply safe conditions.

It is recognized that side clearance and curb details shown here may need be modified for introduction of a walkway section.

Figure 33—As previously indicated the system as recommended would be designed for the provision of access only at the more important intersecting roads or streets. At access points where a large volume of interchange traffic is expected, the lanes for traffic in each direction on the interregional highway would be treated as separate one-way roads, with direct connections for the important right- and left-turning movements. This figure shows three types of such intersection layout. Usually it will be neither necessary nor desirable to provide direct connections for all of the turning movements that might be made within one intersection area.

Figure 34—On divided interregional highways where access is to be provided at a grade separated intersecting road or street and direct connection designs are not feasible, the necessary ramps or connections would be so constructed as to permit exit from and entrance to the interregional highway by

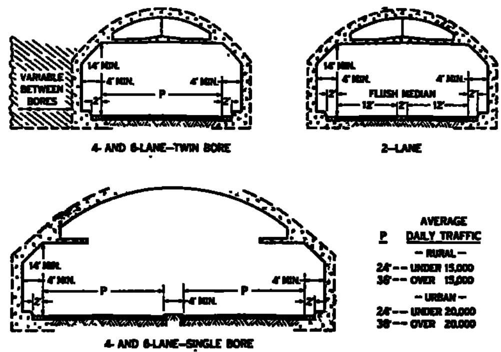


Figure 32. Tunnels

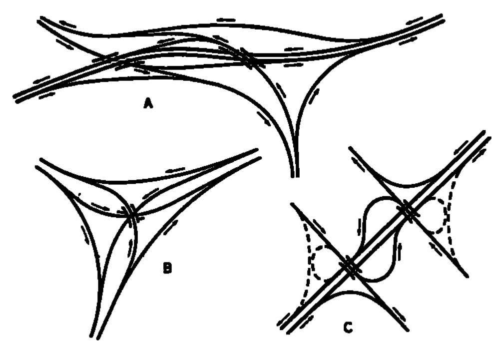


Figure 33. Direct Connections

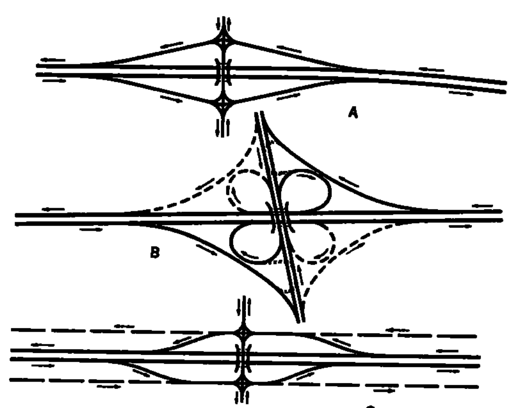


Figure 34. Ramps and Connections

right-turning movements only. Wherever feasible, such ramps or connections would be provided in each of the four quadrants. Sketch 'A' is one such type where conditions require that left turns be made at grade on the crossroad or street.

The whole of Sketch 'B' is a more desirable type, the cloverleaf. Where separate cloverleaf ramps cannot be provided for each turning movement, ramps would be provided in at least two quadrants, one on each side of the interregional highway. A preferred arrangement is shown by the solid lines in Sketch 'B,' with ramps in the nearer quadrant for traffic approaching on the interregional highway. Some left turns would be necessary on the crossroad.

In designs for urban areas where frontage roads are provided, connections of the required types may be made to and from the frontage roads. This can be done near the cross street, as in Sketch 'C,' or connections can be made at desired points apart from the separated cross streets. Frontage road connections would be of such length and position as to provide sufficient storage space for traffic leaving the expressway so that such traffic will not back up onto the expressway if flow is temporarily blocked on the cross street.

Figure 35—It is recognized that grade separations will not be feasible at all points of access on rural sections of the system. At such points of access on divided rural highways on the system the median strip would be at least 40 ft. wide at the intersection. Separate channels would be provided for all right-turning movements and adequate space would be provided for all crossing and left-turning vehicles to stop clear of through traffic lanes and safely proceed across or merge with and emerge from the through traffic. Sketch 'B' shows a design of this type.

On rural sections of the system expected to carry a daily traffic of between 2,000 and 3,000 where access connections are at grade the interregional highway would be widened to a divided highway with a median strip at least 15 ft. wide. The intersection design would be the same as above described for a continuous divided highway.

On 2-lane sections of the system (with expected daily traffic less than 2,000), access intersections at grade would be designed with adequate pavement space for right-turning vehicles to merge safely with and emerge from the through traffic, as in Sketches 'A' and 'C.' In addition the space provided would be sufficient to permit through traffic to pass safely a vehicle pausing for or gaining speed after a left-turning movement. At all intersections at grade on the system vehicles on the crossroad would be required to come to a complete stop before crossing or turning left to enter the interregional highway. From such point of stopping the sight distance in each direction along the interregional highway would be sufficient to permit safe crossing or entering of the through lanes.

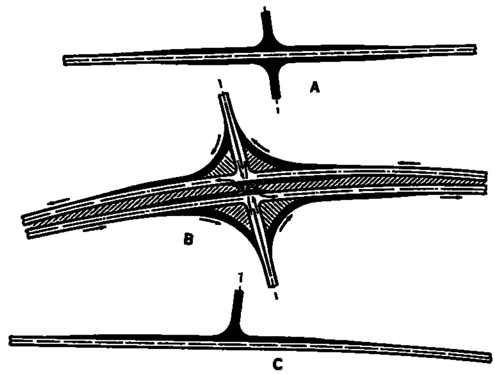


Figure 35. Intersections at Grade

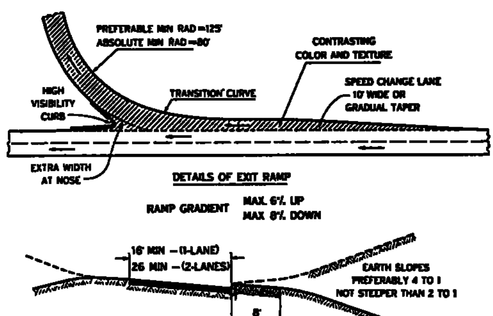


Figure 36. Ramp Details

Figure 36—Both at intersections at grade and at grade separations the entrances and exits on the system would be of a form to provide space for acceleration or deceleration and maneuvers required for vehicles to emerge safely from or merge with the through traffic stream. This added space may take the form of a taper, or a taper combined with an added lane at least 10 ft. wide. Such facilities for speed-change would be smoothly alined and of a length consistent with probable speed of travel. The pavement surfaces of all ramps

or connections and all added width for maneuvering would contrast in color and preferably in texture with the through traffic pavement.

Ramps at grade separation preferably would be one-way roads for the whole length. Where such design is not feasible, two-way ramps would be separated by suitable channelizing islands into one-way roads for exit from and entrance to the interregional highway. If necessary the same would be done on intersecting streets or roads.

All ramps and connections would be designed to enable vehicles to leave and enter the lanes of the through highway at 0.7 of the highway's design speed. All ramp curves would be eased by transitions or compounding. On the portions of ramps or connections removed from the through traffic lanes, i.e., beyond the exit or entrance curve proper, a radius preferably at least 125 ft., and in no case less than 80 ft., would be provided. On two-lane portions of the system with daily traffic less than 2,000 vehicles, smaller radii connections may be necessary, but to the extent possible the same control radii would be used.

At exits from a through traffic lane, as at left of the upper figure, added width of pavement and a taper beyond the nose at the fork would be provided. A curb of high visibility should be used around and beyond the nose.

Gradients on ramps would not exceed 6 per cent on upgrades and 8 per cent on downgrades.

Ramps and connections designed for one-lane operation would have a width of at least 16 ft., or 26 ft. when designed for 2-lane operation. Greater widths would be required around sharply curved portions of ramps and connections. A shoulder at least 6 ft. and preferably 8 ft. wide would be provided on the right side in the direction of traffic, of all ramp pavements. Side slopes on ramps would be not steeper than 2 to 1, and would be rounded at top and bottom to merge by curves of natural appearance with the adjacent land slopes or shoulders.

All ramps and connections would be designed to provide sight distances consistent with the probable speeds of vehicle operation.

Access connections for bus stops and roadside businesses would be designed to the same standards as other access connections. Bus stops would be prohibited on the through traffic lanes of the system. Likewise, no roadside businesses would front directly on the through lanes.

Figure 37—The design of the system would be such as to reduce to a practicable minimum the need for signs and pavement markings. Installation of traffic control signals would be prohibited. The necessary signing and marking would be uniform throughout all States, and of a detail appropriate for the volume and speed of traffic. All signs would be reflectorized or illuminated. Whenever feasible all pavement markings would be reflectorized. All 2-lane sections on which passing is unsafe would be appropriately and conspicuously marked as no-passing zones.

This sketch illustrates typical signs at a grade separation as they would be seen by a driver on the interregional highway moving

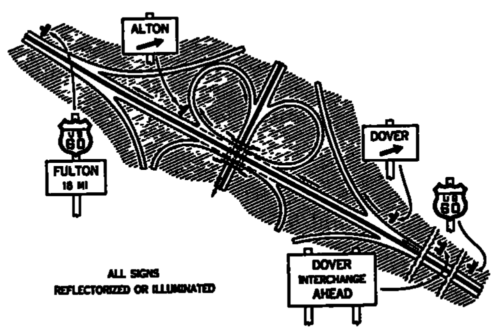


Figure 37. Typical Signs

from the lower right to the upper left. All sections of the system would be marked with standard US route markers, as at the right.

All points of entrance and exit at a grade-separated intersection would be designated as "interchanges," each identified by an appropriate local name or number. As shown by the second sign—"Dover Interchange Ahead" —warning of an approach to an interchange would be provided by a sign located a suitable distance in advance of the intersection.

At each point of turning from the interregional highway a sign would be provided showing the name of a single nearby city, locality or cross highway. The third sign—"Dover"—on the right of the structure in the drawing and the similar sign—"Alton"—on the left are examples of such directional signs.

Immediately beyond the interchange there would be placed a confirmatory route marker and a sign showing the distance to the next important city or interchange, as shown here at the left of the drawing.

Similar signs would be used at intersections at grade, modified as necessary to show directions for both right and left turns. Appropriate signs and markings also would be installed at points of access on streets or highways approaching the interregional highway.

Along the interregional highway advisory speed control signs would be posted wherever the design speed is less than 70 mph on rural sections or 50 mph on urban sections, or as might be necessary to give notice of State or local regulations.

Four-inch white lines would be used to indicate traffic lanes on the interregional system, continuous lines on 2-lane roads and dashed on multi-lane roads. No-passing zones would be marked by an additional barrier line, used in conjunction with proper signs.

All urban sections of the system would be lighted and wherever feasible rural sections would also be lighted. Except as necessary for illumination of the highway the erection of light, power and telephone poles and the construction of underground utilities within the right-of-way would be discouraged.

Figure 38—Highways of the type desired on the Interregional System require consideration of landscaping as well as engineering principles at all stages of the location, design and construction. These landscape principles are considerably more than a series of last stage details, such as tree planting and slope protection.

The essence of good landscaping is the fitting of the road gracefully into its natural environment, moulding it into the terrain to make it a harmonious feature of the natural landscape. Proper regard for these features in location and design will simplify and increase the effectiveness of maintenance processes and lower the cost of adequate upkeep. The flattened side slopes will favor the growth of vegetation, prevent erosion and thus remove the cause of much troublesome clogging of the drainage system. The easier slopes can be mowed by machine instead of by hand methods, and the smooth-flowing contours of cut banks will reduce snow drifting and facilitate snow removal.

In a broader sense attention to other than strictly engineering details will permit the location, design and construction of the highway so as to preserve and best utilize the points of natural beauty that may exist along or within sight of it. In the design of the system there should be no sparing of whatever thought and care may be necessary to place these roads in locations of utmost fitness from every point of view, consistent with the primary requirements of traffic service. In urban areas the sections of the system should be so treated as to accomplish elongated parks, bringing to the inner city a welcome addition of beauty, grace and green open space.

In brief the landscape requirements for the Interregional System, as conceived by the Committee, are that whenever feasible the design would conserve desirable and irreplaceable landscape features, avoid needless damage to desirable trees and other growth and to lake and stream shores, and preserve natural sites for the development of overlooks, picnic areas and other desirable wayside attractions. The design, combined with recovering of disturbed surfaces and other landscaping, would be planned to protect the highway against erosion by wind and water, to reduce maintenance to a minimum, and to enhance the natural appearance of the road and the wayside.

It is obviously impossible to demonstrate all of these landscape features in photographs of highways meeting the standards that have been described. But this and the next view are examples that show in a general way the type of finished highway facility that would be provided. This view shows a rural 2-lane highway that has been fitted to the terrain in a manner that is not only functional but also efficient and pleasing. In nearly every detail this is a highway meeting the rural requirements of these standards.

Figure 39—This is a divided highway in a suburban area, the whole of which shows good balance and adjustment of the traffic facilities to the surrounding terrain and natural growths. In most details this improvement meets the urban requirements of these standards.

Conclusion—In this series of charts it has been attempted to demonstrate the major controls of the standards proposed by the

National Interregional Highway Committee for development of the Interregional—or Interstate—System of highways. These standards were described in detail in the report of the Committee in order to portray clearly the type of improvement advocated for a major national system of optimum length. It is recognized that an Interregional System can be developed only through cooperation of local, city, county and State agencies, and it is necessary that their representatives assist in the determination of the standards finally to be adopted for the system. The Highway Act of 1944 paved the way for the start of the system development, and it now is essential that design controls agreeable and acceptable to all be determined for rapid consummation of the big job ahead.

Figure 38. Typical Rural Improvement

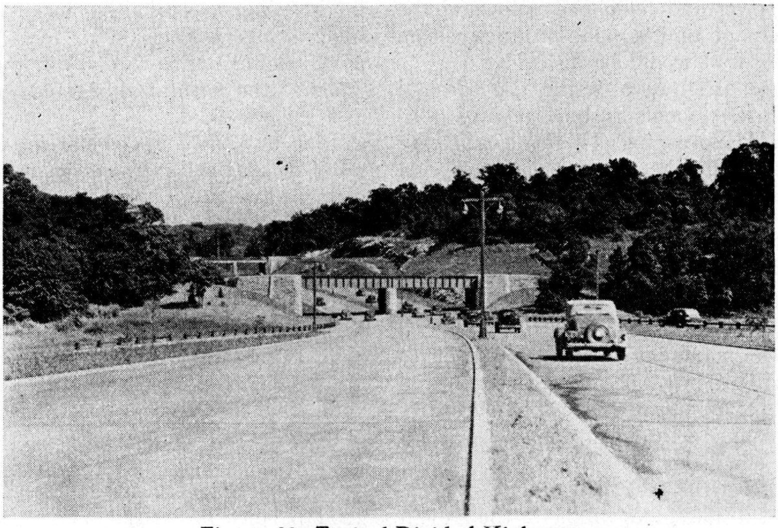


Figure 39. Typical Divided Highway