INFLUENCE OF BRIDGE WIDTHS ON TRANSVERSE POSITIONS OF VEHICLES

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SYNOPSIS

Using the average transverse positions of freely moving and meeting passenger cars as an index, it is found that an 18-ft pavement with 3-ft shoulders requires a concrete bridge of from 26 to 28 ft in width This required width increases to 28 or 30 ft when the total roadway width is increased to 34 ft. and the pavement is either 20 or 22 ft wide. The greatest width of bridge required for a 22-ft. pavement was found to be 30 6 ft

Sidewalks apparently add nothing to the effective roadway width on short-span concrete bridges, since the transverse position seems to be based on a fixed distance from the curb, or from the parapet if there is no curb The influence exerted on transverse positions by the height of the parapet seems to be negligible on concrete deck-type structures Results for the one high steel truss studied indicate that such structures should be 4 or 5 ft wider than a deck type for a given width of roadway

Findings are based on studies of eleven bridge locations and adjacent tangent sections of highway

The driver of an isolated vehicle on a tangent section of highway will choose a path on the pavement which requires the least driving effort and which to him seems safest. Any stationary object which may cause him to deviate from the chosen path presents some degree of hazard to the driver and should be removed if practicable Bridge headwalls may be in this class, and while widening these bridges on existing highways may be impractical for economic reasons, all future construction should be planned so that the headwalls will be far enough removed from the pavement that drivers of vehicles crossing the bridge will not be required to alter their course to obtain a feeling of security. Any excess width beyond this point represents unnecessary expense and it is worthy of investigation to determine within rather narrow limits the required width of bridges of various types consistent with various approach roadway widths.

In an effort to determine these proper bridge widths, studies were made of the transverse positions of vehicles at nine bridge locations in Maryland and Virginia. Field data have also been obtained by the Highway Planning Surveys of the States of Ohio, Iowa, Illinois, and Oregon Data for two Oregon bridges are included in this report but in the other named States the information has not yet been sufficiently summarized for inclusion, although the Iowa data were analyzed sufficiently to confirm some of the findings.

Roadway widths on the eleven bridges which form the basis of this report varied from 23 to 50 ft., some bridges were without curbs, some with curbs, and other bridges had sidewalks. One bridge was a high steel truss and another a pony truss. All others were concrete deck types of which one was a high level structure one-half mile in length. Pavement widths on highway approaches were 16, 18, 20, and 22 ft. Transverse positions of vehicles on tangent sections of highway were obtained in the vicinity of the bridges at approximately level locations. The total number of vehicles for which data were obtained was in excess of 20,000, and while this large sample cannot offset the seemingly small number of bridges studied, it removes any doubt as to the reliability of the results obtained for these bridges.

Speeds of all vehicles were also obtained in the field studies, because speeds are doubtless affected by bridges that are too narrow. However, to find a bridge adjacent to a level tangent section where any observed change in speed can be unquestionably attributed to the presence of the bridge is extremely difficult and not more than one or two of the locations studied meet this qualification The vertical alinement in the vicinity of the other bridges would tend to influence speeds to some extent and for this reason the analysis is confined to that of transverse positions. Average speeds at the different locations varied so little that it was felt this factor could safely be neglected insofar as the effect of speed on transverse position was concerned.

Considerable variation was found in the paths of vehicles on the different tangent sections, even on pavements of the same width. The drivers did not seem to gage their positions on the pavement solely by either the center line of the roadway, the edge of the pavement, or the center of the lane in which they were traveling. However, there did seem to be a relationship between the distance of the left wheels of vehicles from the pavement center line and the combined width of shoulders and pavement, or total roadway width. This relationship is shown in Figure 1 for freely moving and meeting passenger cars during both daytime and night time.

The term "freely moving" is here applied to those vehicles that have no preceding vehicle at a time spacing of 6 sec. or less and that have neither met nor will meet a vehicle in the opposing traffic lane within 5 sec. Meeting vehicles are classified as those having no preceding vehicle within a spacing of 6 sec., but having an opposing vehicle at a spacing between zero and 3 sec. Such vehicles have either met, or will meet, within 1½ sec.

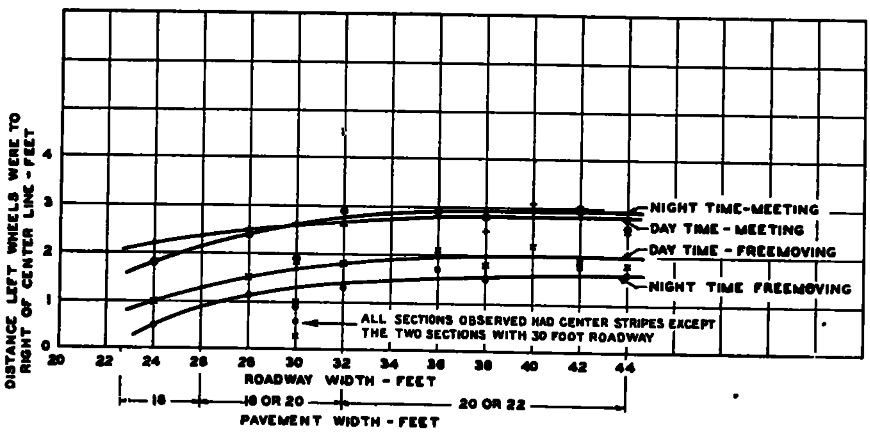

Figure 1. Variation in Transverse Position of Passenger Cars with Roadway Widths

The curves on Figure 1 are drawn to represent what are believed to be average conditions for pavements having some form of center-line marking. It will be noted that on the two sections having no center striping the vehicles traveled much nearer the center of the roadway than they did on the other sections. The minor variation of the plotted points for the other sections is believed to be a result of conditions of the pavement edges, some of which were poor and others exceptionally good. While it is recognized that this relationship between total roadway width and transverse position is not generally applicable, and would certainly fail on pavements of substandard width, it nevertheless provides the most reliable index of driving practice found in this study That the shoulder width does exert a rather strong influence on transverse positions is emphasized by one example in the Iowa studies where the tangent section was made up of a 20-ft. pavement with shoulders of unequal width, being 3 ft. on one side and 4 ft. on the other. The difference in average transverse positions with respect to the center line for the two directions was as much as eight-tenths of a foot.

Having determined the path the average motorist prefers to follow on the highway, a similar analysis is necessary for the bridges. If there were available an unlimited number of bridges of different widths on a given roadway, the problem of determining which of these widths was proper for that particular roadway would be greatly simplified, although the procedure would be rather tedious. However, an intensive search of the area within a radius of 100 miles of Washington failed to produce all the desirable width combinations and it is therefore necessary to take recourse to another method, or that of integrating pertinent facts gleaned from each of the bridges studied, whether they be of proper or improper width, into a general solution of proper widths for any width of roadway.

It was found that the driver is primarily concerned in allowing ample clearance from the bridge headwall, regardless of his position with respect to the center of the roadway. On the great majority of the bridges studied the path of the vehicle was altered by moving transversely toward the left, indicating that these bridges were too narrow. It was observed that in so altering their course these vehicles maintained a distance between their right wheel and curb or parapet that was more or less uniform for all the narrower bridges.

In general the average freely moving vehicle in daytime allowed between 5.9 and 6 9 ft. between the right wheel and curb, and for meeting vehicles this distance was from 4 2 to 6 0 ft. At night the distances were from 6 2 to 7.4 ft for freely moving passenger cars and from 4.8 to 5.5 ft for passenger cars meeting other passenger cars. These results are shown more clearly in Figure 2, where the clearance between right wheel and curb or parapet is related to the amount the vehicles moved transversely in travel-

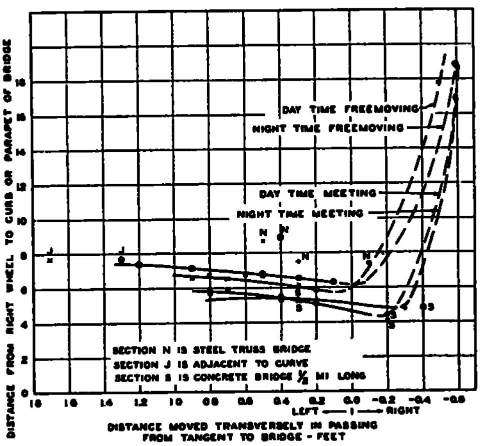

Figure 2. Clear Distance Allowed Between Right Wheels of Passenger Cars and Curb or Parapet Wall of Bridges.

ing from the tangent section to the bridge. For example, freely moving vehicles at night moved toward the center of the roadway a distance of 1 2 ft at one bridge location to allow a clear distance from the curb of 7.4 ft. On other bridges the distance moved toward the center of the roadway was not so great, but the clearance from the curb for vehicles in this class was never less than 6 2 ft. On the other hand it may be said that any excess clearance beyond 6 or 7 ft. which results when a vehicle crosses a bridge without deviating from the path it followed on the highway represents unnecessary bridge width, as in the case of the 50-ft. bridge where clearances of 17 or 18 ft. were recorded On the narrower bridges passenger cars altered their course to a lesser degree when meeting on the bridge than when moving freely, and at the same time allowed less clearance between their right wheel and the curb.

For the truss bridge it was found that the clearance from the right wheel to curb was between two and three feet greater than that observed on the concrete bridges. Passenger vehicles under all conditions moved to the left in crossing this bridge and these results indicate that high truss bridges should be four or five feet wider than concrete deck bridges of suitable width if the path of vehicles with respect to the center line is to be the same on both the bridge and pavement. Also of significance is the fact that sidewalks apparently added little if any to the effective width of the concrete bridges, since the clearance required between the wheel and curb was approximately the same as that required on bridges without sidewalks.

On the long-span concrete bridge the clearance between right wheel and curb, at the point selected for study, was considerably less than that on the short-span bridges The placement data were recorded on this bridge at a distance of about 600 ft. from one end and these data support the belief sometimes expressed that bridges of lesser width can be used on long spans if the bridge entrance is made sufficiently wide, and suitable transition from this to the lesser width is provided.

For complete freedom of movement on a bridge, vehicles should be able to meet one another with the same clearance that they allow while meeting on the highway, and at the same time there should be as much clearance from the curb as is allowed by vehicles moving freely. Conversely, if the same clearance is to be allowed between cars when meeting on the bridge as when meeting on the highway, the bridge must be of sufficient width to preclude any tendency of the vehicles to swerve toward the left. This requires that the clearance from the curb to the right wheel of meeting vehicles be not less than that allowed by freely moving traffic. One-half of the bridge width should then equal the sum of the three following items:

1 The distance of the left wheel to the right of the center line for vehicles meeting on the tangent section, which is equivalent to one-half the clearance between the left wheels of vehicles when meeting.
2. The tread width of the average car, or approximately 5 ft.
3 The distance freely moving vehicles preferred to allow between their right wheels and the curb or parapet of the bridge.

The first of the foregoing items is determined from the curves of Figure 1, and the third from Figure 2. It develops that nighttime traffic requires a slightly greater width than does daytime traffic. The required width of bridge for various roadway widths, computed on the above basis for nighttime traffic, is shown graphically in Figure 3. Because freely moving vehicles allowed a distance varying from 6 2 to 7.4 ft. from right wheel to curb on the bridge, two curves are shown in Figure 3· one for the upper limit and one for the lower limit. On a 20-ft pavement having 6-ft. shoulders, which is a common width of roadway, bridges should be about 28 or 30 ft wide. The greatest bridge width required for a 22-ft. pavement, as found by these investigations, is 30 6 ft, or 8.6 ft. greater than the pavement width

For short-span bridges, where the additional expense of the extra width is slight, the greater widths, or those shown by the upper limit curve are suggested.

On longer bridges, where the additional expense of construction is considerable, the lesser or lower limit widths are acceptable No existing bridge whose width is as great as that indicated by the lower limit curve should be considered for reconstruction by reason of its width alone.

It is worthy of mention that the parapets on the concrete bridges varied in height from 2.0 to 5 0 ft. If this variation in height exerted any influence on the transverse positions of vehicles, it was so small as to be unrecognizable. Traffic behavior on the pony truss also seemed to be unaffected by the height of the truss, which was 9.5 ft. above the roadway. However, little emphasis is placed on this latter apparent finding since the highway had no center striping and this factor doubtless influenced the position of the vehicles crossing the bridge. Behavior on a pony-truss would be expected to conform more nearly to that on a truss bridge, for which it was found that the width required was about four or five feet greater than that for a concrete bridge.

In reaching the conclusion that the bridge widths shown in Figure 3 are proper, no consideration has been given to the requirements of truck traffic. The number of trucks recorded at the locations studied was not sufficiently large to permit of any conclusive analysis, but it is not unreasonable that if the roadway width on the highway is great enough to accommodate truck traffic as well as passenger car traffic, then a bridge width suitable for passenger car traffic on that highway will also be suitable for truck traffic. The results of the studies now in process of analysis by the Iowa State Highway Commission should provide a more definite answer to this question.

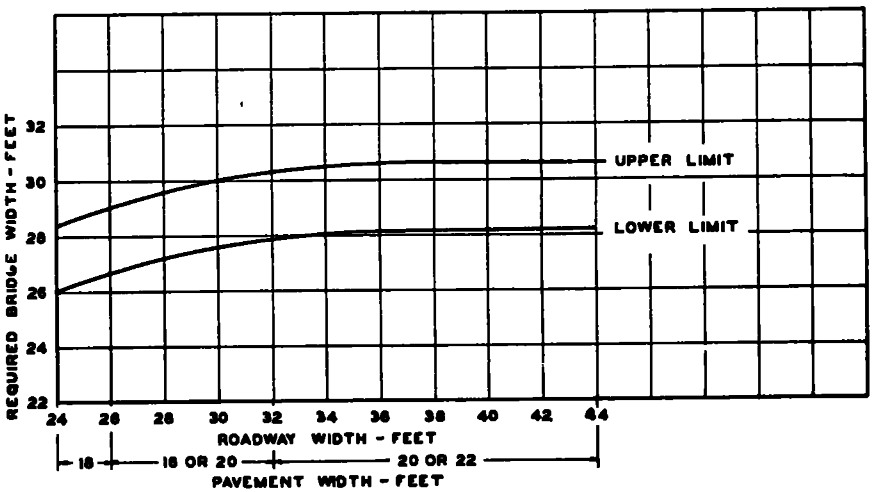

Figure 3. Minimum Adequate Widths of Concrete Bridges for Various Widths of Roadway