Headlight Glare vs Median Width

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● THE GLARE of approaching headlights reduces a driver's ability to see. When the lights of an approaching automobile remain on high beam during the passing maneuver, most drivers are blinded by the dazzling light and are unable to observe clearly an obstacle on the highway within the limits of the driver's headlight illumination.

The object of this study is to determine the median width that will best avoid this blinding glare from high-beam headlights of oncoming automobiles, and therefore, allow a driver to see an obstacle on the highway at a safe stopping sight distance.

EQUIPMENT

The equipment used in this study included two state vehicles—No. 2687 (1957 Chevrolet Station wagon), No. 2719 (1957 Chevrolet pickup), and a G.E. illumination meter (range—0.2 to 500 foot-candles).

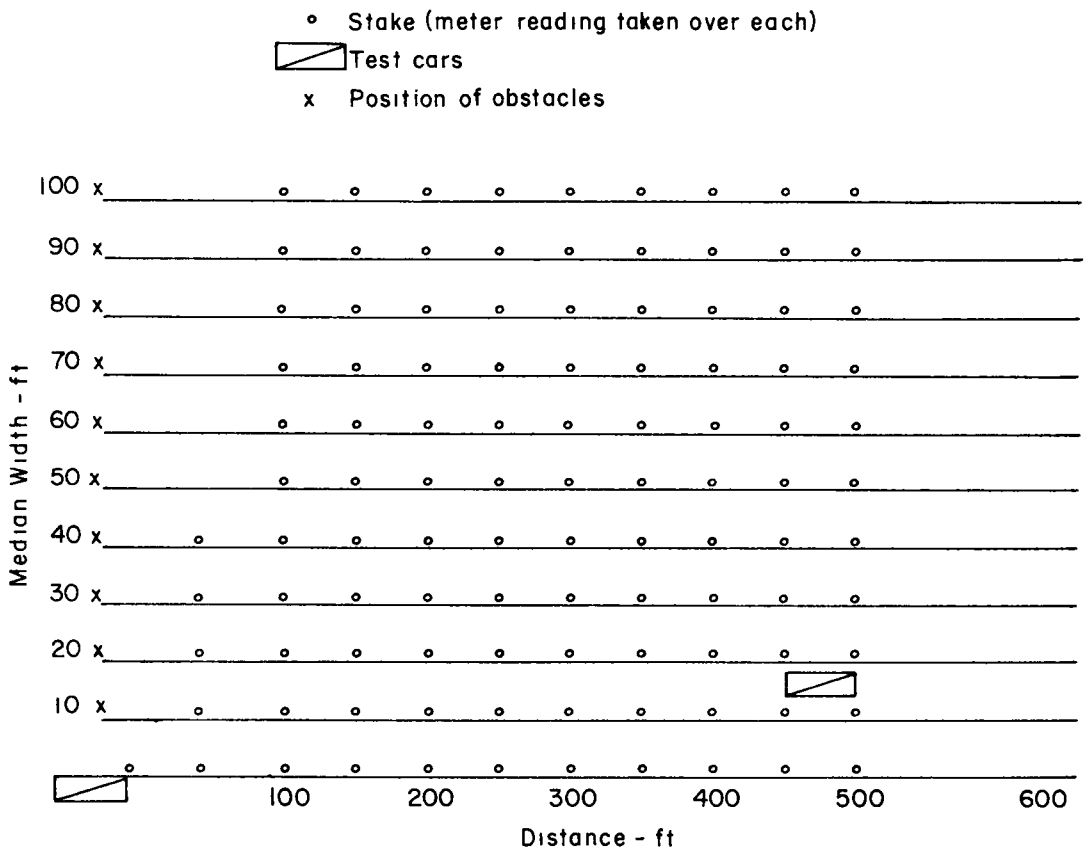

Figure 1. Plan of track used for tests.

PROCEDURE

Test A

This test was carried out on a graveled airplane runway with small vegetation growing thereon. This vegetation was, in general, small shrubs, weeds, and grass which is more or less representative of anticipated median texture. The runway was chosen because it provided a reasonable length of straight track without curves. Ten lengths of track were used to run the tests, the dimensions and layout of which are shown in Figure 1.

A baseline was stationed in 50-ft intervals for 600 ft. From the baseline, six 10-ft lanes were laid out. A test driver would then drive down each lane at an average speed of 45 mph toward a stationary vehicle parked on the baseline at Station 0/00. Both automobiles had their headlights on high beam. An obstacle was placed in the lane down which the moving auto would travel. This obstacle was opposite the stationary automobile, but far enough back so that the vehicles' lights would not reflect on the obstacle.

There were two men in the test auto. The driver stated when he could see the obstacle, while the other man dropped a marker at that point. The driver made several test runs, starting with the 10-ft median, then the 20-ft median, and so on, until there was no glare, or until he could clearly observe the obstacle with his headlights alone. A total of seven drivers performed the test.

Test B

To check the results obtained in Test A, a source intensity curve with candlepower as a function of median width and distance from source was prepared.

To determine these curves, meter readings of illumination at 50-ft intervals were taken on each 10-ft median increment, and were then converted to a measure of source intensity expressed in candlepower by the relation $I = ER^2$, in which I = source intensity in candlepower, E = illumination in foot-candles, and R = distance from source in feet.

During the test the stationary vehicle remained at station 0 + 00 on the baseline with headlights on high beam, while another auto was driven over each 50-ft station on each lane. An illumination reading was taken through the windshield at the same height as the driver's eyes.

RESULTS AND CONCLUSIONS

The results obtained during Test A are summarized in Table 1. This table was prepared from the observations of the seven drivers tested, and shows the minimum safe median widths with high-beam headlights for design speeds from 30-70 mph. The individual distance curves plotted for each driver and a sight distance curve, which is a calculated statistical average for the seven drivers tested, are shown in Figure 2.

The results obtained during Test B are shown in Figure 3. This figure was prepared from the data given in Tables 3 and 4 (Appendix). The light intensity curves show a definite relation with the observations of the seven drivers run through the test. The average curve has been plotted with these curves to show this relation. The light intensity curves indicate that the 25,000 contour of illumination is the safe maximum candlepower allowable for desirable minimum glare.

TABLE 1

Design Speed (mph)	Safe Stopping Sight Distance (ft)	Median Width[a] (ft)
30	200	10-20
40	275	20-30
50	350	30-40
60	475	50-60
70	600	60-80

[a]Minimum safe median widths with high-beam headlights. Two cars passing on 4-lane divided highway.

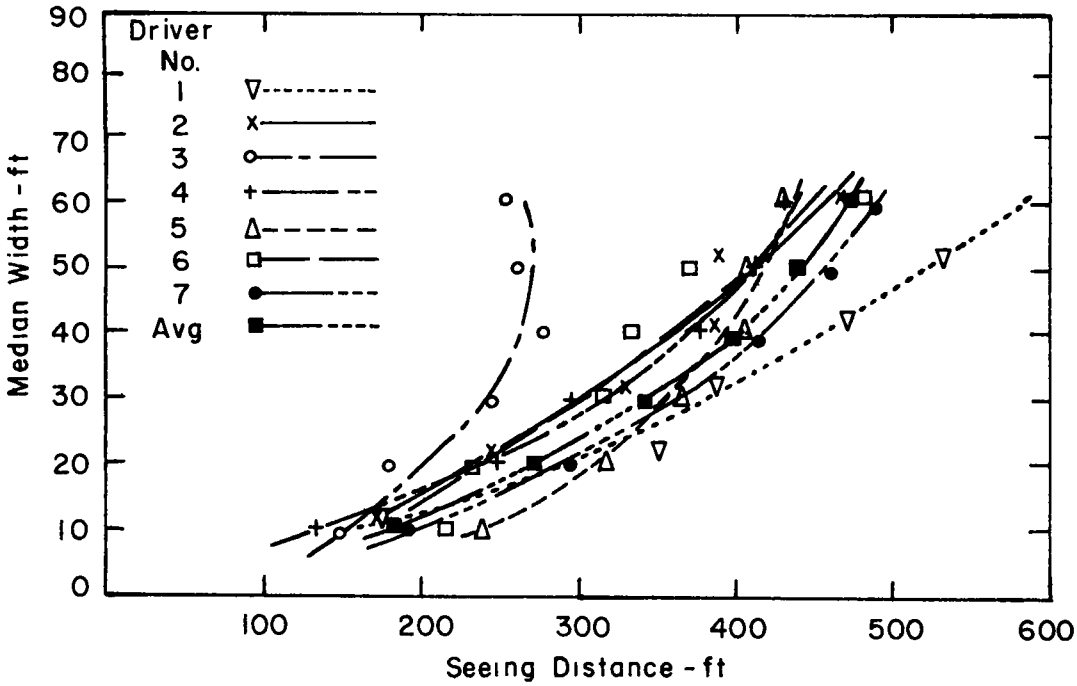

Figure 2. Seeing distance as function of median width.

Both tests have the following conditions in common:

1. Tests were run on clear, moonless nights.
2. The median widths were made of small shrubs, weeds, and grass; reflection was very low.

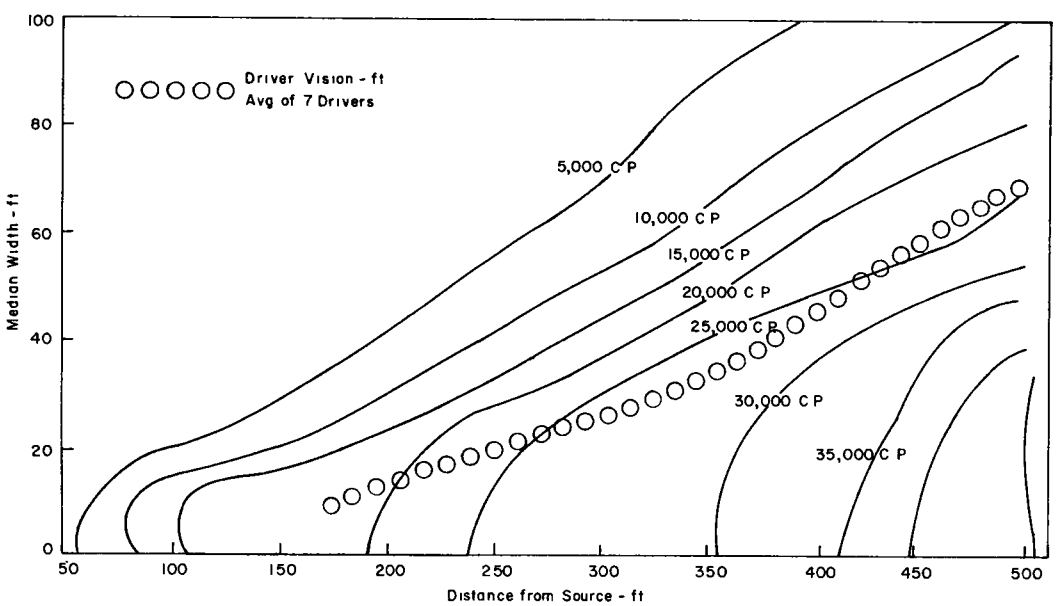

Figure 3. Source intensity as a function of median width and distance from source.

3. The obstacle was made of wood in an "A" shape about 2 ft high.
4. The target was placed in a different position on each lane so that the driver would not know where to look for the obstacle.

A review of the test as a whole suggests that more complete and varied investigations should be made to definitely establish the relation of median widths to sight distance against opposing high-beam headlights. These tests were run under one condition, considered to be average. Variable conditions, such as glare on wet surfaces, light-and dark-textured surfaces, driver characteristics, vehicle speed, and type of headlights, would create considerable differences in the degree of discomfort and/or safety introduced in the operation of vehicles on four-lane divided highways.

RECOMMENDATIONS FOR FURTHER STUDY

The conclusions expressed in this report are based on a minimum number of observations using equipment and personnel assumed to be average. It is hoped that further studies will be initiated to substantiate and expand the results obtained.

Additional studies of the following subjects would be considered especially valuable in median design.

1. The relation of safe stopping sight distance to median width against opposing low-beam headlights.
2. A comparison of light intensity curves obtained from standard headlights as opposed to those obtained from the latest quadra-beam headlight designs.
3. The effect of horizontal roadway curvature with various median widths on sight distance against opposing low- and high-beam headlights.
4. The effect of differences in roadway elevation with various median widths on sight distance against opposing low- and high-beam headlights.

Appendix

TABLE 2

NIGHT VISION DATA

Driver No.	Distance from Object (ft)[a]					
	10-ft Median	20-ft Median	30-ft Median	40-ft Median	50-ft Median	60-ft Median
1	180	325	365	470	500	560
2	165	225	305	375	375	450
3	150	180	240	285	260	250
4	140	240	290	360	390	400
5	230	300	350	390	390	400
6	200	210	300	310	350	460
7	190	290	350	400	440	455
Average	184	262	335	389	416	457

[a]No glare with medians wider than 60 ft.

TABLE 3

INTENSITY OF ILLUMINATION

Distance From Light (ft)	Illumination Intensity (ft-cd)										
	0-Ft Median	10-Ft Median	20-Ft Median	30-Ft Median	40-Ft Median	50-Ft Median	60-Ft Median	70-Ft Median	80-Ft Median	90-Ft Median	100-Ft Median
50	1.85	0.81	0.20	0 05	0 0	0.0	0.0	0.0	0 0	0.0	0.0
100	1.20	1.40	0.30	0 10	0.05	0 01	0.01	0.01	0.0	0.0	0 0
150	0.80	0.95	0.38	0 18	0.07	0.05	0.02	0.01	0.01	0.0	0.0
200	0 51	0 50	0.42	0.20	0.10	0.07	0.04	0.03	0 02	0.0	0.0
250	0.42	0 40	0.39	0.21	0.11	0.08	0.06	0.04	0.03	0.01	0.01
300	0.30	0.28	0.23	0.22	0.15	0 10	0.08	0.05	0 04	0 02	0.01
350	0.22	0.21	0.20	0.22	0.19	0.16	0.09	0.06	0.05	0.04	0.02
400	0.21	0.20	0.18	0.20	0.18	0.14	0 13	0.07	0.06	0.05	0 03
450	0.20	0 19	0.19	0.17	0.17	0.14	0.12	0 08	0.07	0.05	0.03
500	0 18	0 18	0 18	0.17	0.15	0.15	0.10	0.09	0.08	0 07	0.04
600	0 15	-	-	-	-	-	-	-	-	-	-

TABLE 4

LIGHT INTENSITY[1]

Distance From Light (ft)	Intensity, $I = ER^2$ (cd)										
	0-Ft Distance	10-Ft Distance	20-Ft Distance	30-Ft Distance	40-Ft Distance	50-Ft Distance	60-Ft Distance	70-Ft Distance	80-Ft Distance	90-Ft Distance	100-Ft Distance
50	4,625	2,106	579	170	0	0	0	0	0	0	0
100	12,000	14,140	3,120	1,090	581	125	136	149	0	0	0
150	18,000	21,470	8,700	4,212	1,687	1,250	522	274	289	0	0
200	20,400	20,050	16,968	8,180	4,160	2,975	1,774	1,347	928	0	0
250	26,250	25,040	24,570	13,314	7,040	5,160	3,960	2,696	2,067	706	726
300	27,000	25,228	20,792	19,998	13,740	9,250	7,488	4,745	3,856	1,962	1,000
350	26,950	25,746	24,580	27,148	23,579	20,000	11,349	7,644	6,445	5,224	2,650
400	33,600	32,020	28,872	32,180	29,088	22,750	21,268	11,543	9,984	8,405	5,100
450	40,500	38,494	38,551	34,578	34,697	28,700	24,732	16,592	14,623	10,530	6,375
500	45,000	45,018	45,072	42,653	37,740	37,875	25,360	22,941	20,512	18,067	10,400
600	54,000	-	-	-	-	-	-	-	-	-	-

[1]At given distance from baseline.