THE RELATION OF HIGHWAY LIGHTING TO HIGHWAY ACCIDENTS

By Arnold H Vey

Traffic Engineer, State of New Jersey

SYNOPSIS

Following a brief discussion of motor vehicle accident experience and the part that highway facilities play in the accident problem, the New Jersey accident records for 1933 are analyzed from the standpoint of comparative frequency during daylight and dark There were 33,803 accidents recorded, of which 44 per cent were at night or when traffic was about 20 per cent of the 24-hour total

These data are analyzed by segregating the day and night groups of accidents by types, kinds of vehicles, weather and road conditions Accidents involving fixed objects, passenger cars, and unfavorable weather conditions appear to show larger percentages of night accidents than of daytime accidents

Analysis of accident experience in 1933 along the unlighted highway from the Newark Airport to Trenton showed that approximately one half of the total accidents and 63 4 of the fatal accidents occurred at night On comparing this unlighted section with the lighted section of this same road from Newark Airport to the Holland Tunnel it was found that on the unlighted section those types of accidents that might have been caused by insufficient visibility were more prevalent at night, but on the lighted road accidents of all kinds occurred more often in daylight

These studies together with those reported by other investigators show the value of street and highway lighting It is concluded that there is a definite relationship between highway lighting and highway accidents and that in general where adequate lighting is provided there is a substantial reduction in night accidents

The importance of "seeing" as a factor in the problem of reducing economic losses and human suffering caused by motor vehicle accidents is stressed

To provide for safety and convenience on our streets and highways is the most important duty of traffic authorities and officials today

The average motorist, pedestrian, and official, are outspoken in their opinions or beliefs concerning the causes of motor vehicle accidents and their prevention. Seldom are such opinions and beliefs based upon clear and comprehensive knowledge of accident facts, nor does the average person study accident experience after the application of selected remedies

Such is particularly the case concerning highway accidents that occur at night

Many facts have been given and cases analyzed proving the necessity for adequate and proper highway lighting to bring about better seeing conditions and safer night travel upon the highways In the face of all the publicity given these facts, many officials and many more motorists

believe that highway lighting is unnecessary, that it is too extravagant, that it represents one of the luxuries of the pre-depression period and, therefore, it must now be curtailed and, above all, budgets should not now be increased to provide adequate street or highway lighting

There are also those who feel that the driver is responsible for most accidents and that, regardless of the presence of up-to-date highway facilities, such as highway lighting, accidents will not be materially curtailed

Such erroneous opinions are formed by experience with "just" lights on the highways and not modern highway lighting as recommended by the best minds of the illuminating engineering field

Modern highway lighting combines efficient re-directing equipment with mounting heights of 22 to 28 ft , as well as placement of the luminaire over the travelable portion of the highway Other considerations are the size of the lamp and luminaire with respect to the type, volume, and speed of vehicles, as well as to the type and character of road topography and conditions immediately adjacent to the road Such scientific study results in proper seeing conditions at night with lessened strain upon the driver and greater safety

It is true that an analysis of motor vehicle accident records alone will show that the majority of accidents—probably 85 per cent or more—are chargeable to some improper action on the part of the driver or drivers involved

Most drivers, however, subject themselves to the possibility of accidents not generally because of wilfulness but because of carelessness, habit, or lack of sufficient knowledge of the hazards encountered, as for example, driving at too fast a speed at night for the visibility generally afforded

The three factors in motor vehicle accidents are the vehicle, the highway and the driver Of these three, the driver is the most difficult with which to deal because of his individual characteristics, including mental and physical make-up, and his varying degrees of reaction to the everyday problems of life In order to cope with the weaknesses of mind and body of highway users and to bring about safety upon the highways, it is fundamental that roadways be provided which are inherently safe 24 hours a day

Highway lighting is such a facility which has been applied in very few unconnected portions of the more important roadways of the country The illumination of our highways for safe night travel, has not kept pace with advancement in roadway construction and in my opinion the maximum benefits of highway lighting have not been obtained because of failure to use at all or use properly modern scientifically designed equipment

A review of accident records, not only for New Jersey but other sections of the country, will demonstrate the correctness of the above statement

DAY VERSUS NIGHT ACCIDENTS

In New Jersey 1933 there were recorded 33,803 highway accidents, which caused 1,185 deaths and more than 28,000 personal injuries Of these accidents, 44 per cent of the total and 55 per cent of the deaths occurred at night or during times when traffic was approximately 20 per cent of the 24-hour total

The National Safety Council, in its pamphlet entitled "Accident Facts," states that in 1933, 58 per cent of all fatal motor vehicle accidents occurred during dusk or darkness Therefore, New Jersey's experience parallels that of the entire country

Assuming that the ratio of night traffic to 24-hour traffic is the same for the entire country as for New Jersey, it may therefore be determined that night accidents throughout the country occur upon the highways approximately four times as often as day accidents

Many interesting and valuable facts are produced by a study of motor vehicle accident records in New Jersey for 1933 These data, segregating accidents by types, kinds of vehicles involved, weather conditions and road conditions, and separating each group into day and night accidents, are shown in Tables I to IV

TABLE I

Involved	Percentage of Total Day Accidents	Percentage of Total Night Accidents
Pedestrian	26 1	25 4
Other Motor Vehicle	62 9	62 2
Fixed Object	4 5	7 0
Non-collision Operating	2 7	2 5
Miscellaneous	3 8	2 9
	100 0	100 0

In Table I it may be seen that there is only a slight variation between the ratios of different types of daylight accidents to total daylight accidents and the ratios of the same types of night accidents to total night accidents, with the exception of the fixed-object type In this case the ratio of fixed object night accidents to total night accidents is greater by 2 5 to 100 than the ratio of this type of accident in daylight to total daylight accidents

Types of Vehicles Involved

Table II indicates that the percentage of night accidents involving passenger vehicles is greater by 8 per cent than the corresponding percentage of daylight accidents, while, in the case of commercial vehicles, just the reverse occurs The ratio of night accidents to total night

accidents, compared with day accidents to total day accidents for buses and taxicabs is more or less the same

An explanation of the greater percentage of passenger vehicles involved in night accidents, and a more or less similar decrease in the case of the commercial vehicle class, is the fact that during daylight hours there is a prevalence of the light type of commercial vehicle upon the highways, such as the small delivery vehicle used by merchants and business concerns for deliveries Generally, these vehicles are owned by small organizations and driven by young drivers who are not under the same degree of control or do not have the same experience and safety training as drivers of the larger commercial vehicles On the other hand, drivers of passenger cars are substantially the same kind of individuals both during daylight and dark hours

TABLE II

Type of Vehicle	Percentage of Total Day Accidents	Percentage of Total Night Accidents
Passenger	77 1	85 0
Commercial	18 6	10 6
Bus	2 2	2 0
Taxi	8	1 2
Other	1 3	1 2
	100 0	100 0

Weather and Road Conditions

Tables III and IV show greater prevalence of daylight accidents than night accidents when weather and road conditions are favorable However, under unfavorable weather and road conditions, such as during fog, rain or snow, or during times when pavements are wet, snowy or icy, the reverse is true In other words, unfavorable weather and pavement conditions accentuate the hazards of night driving

Accident Experience along State Highway Routes No 25 and 26

Some of the facts shown by a detailed analysis of accident experience for the year 1933 along one of New Jersey's most heavily traveled highways—that roadway from the Newark Airport in the City of Newark to the Trenton traffic circle in the City of Trenton—are as follows.

Along this approximately 50-mile stretch of highway having four lanes of concrete pavement for travel, in addition to unpaved shoulders adjacent to the pavement, a clover leaf grade separation at a major crossing, traffic circles at several other important intersections, and traffic control signals at intersections where cross street traffic is sufficient to warrant the alternation of the right of way, there were 1,102 accidents, 50 6 per cent of which occurred during hours of darkness

Of the 1,102 accidents, 65 caused fatalities, of which 63.4 per cent occurred at night Of the non-fatal personal injury accidents, which concerned slightly more than one-half of the total accidents, 53 per cent occurred during hours of darkness, and of the property damage accidents, which amounted to slightly more than one-third of the total, 45 5 per cent occurred during hours of darkness

Of the total number of accidents, 524 or 47 6 per cent occurred at street intersections Of these 42 8 per cent occurred during hours of darkness Of those which occurred between intersections, 58 5 per cent were during hours of darkness

Of the various types of accidents which occurred at or between intersections, 7 2 per cent involved vehicles approaching at right angles,

TABLE III

Weather Conditions	Percentage of Total Day Accidents	Percentage of Total Night Accidents
Clear	82 8	74 1
Foggy	7	2 5
Rainy	13 6	18 9
Snowy	2 9	4 5
	100 0	100 0

TABLE IV

Road Conditions	Percentage of Total Day Accidents	Percentage of Total Night Accidents
Dry	80 1	71 5
Wet	14 3	20 3
Snowy	2 8	4 1
Icy	2 8	4 1
	100 0	100 0

44 2 per cent involved vehicles going in the same direction—either rear-end, cutting in or side-swipe collisions, 19 3 per cent involved vehicles going in opposite directions, 8 3 per cent involved fixed-object collisions, 8 9 per cent involved collisions with pedestrians, 12 2 per cent involved miscellaneous accidents or accidents concerning which a complete report was not made

From all of the above, it may be determined that along this stretch of highway—protected at major intersections by either grade separations, traffic circles or traffic signals—approximately one-half of the total accidents and more than one-half of the fatal accidents occurred during hours of darkness

Although a few street lights are provided at isolated points and at a

few intersections, it may be said that this stretch of highway falls in the category of unlighted roadways

A comparison of day and night accidents, by types, between this unlighted highway and a lighted one has been made The lighted stretch of highway selected is a continuation of the unlighted stretch and represents that portion of Route No 25 from the Holland Tunnel entrance to the Newark Airport and is lighted to a degree comparable to the recommendations of illuminating engineers

For example, along the unlighted section, it was found that accidents which occurred during times of more or less congestion, such as right angle collisions, collisions between vehicles going in opposite directions where one vehicle was making a left turn and miscellaneous accidents, were more prevalent during hours of daylight, but that other types of collisions, which might have occurred because of insufficient visibility, such as same direction accidents (most of which are rear-end collisions), head-on collisions and pedestrian accidents, occurred more frequently during hours of darkness In percentage, it was found that for these three latter types of accidents, there was an increase of night over day accidents of 8, 19 and 72 per cent, respectively

Along the lighted highway accidents of all types, with the exception of fixed object collisions, occurred more frequently during hours of daylight, ranging from 27 to 80 per cent

When considering accidents of all types, it was found that along the unlighted stretch, there was an increase of 2 5 per cent of night accidents over day accidents, while along the lighted stretch there was a decrease of 43 per cent

Along the unlighted section of Route No 25, from the Newark Airport to the Trenton traffic circle, it was found that 186 of the same direction accidents concerned rear-end collisions, of which 95 or 52 per cent occurred during hours of darkness, while along the lighted stretch from the entrance to the Holland Tunnel to the Newark Airport 28 of the same direction accidents were recorded as rear-end collisions, of which 8 or only 29 per cent occurred at night

Accidents Concerning Pedestrians Killed or Injured While Walking on or Along Roadway

To determine the extent of accidents involving pedestrians who were walking on or along a roadway a review has been made of such accidents in New Jersey for 1933 These accidents primarily concerned highways in rural districts where sidewalks were not provided for pedestrian use This study showed that there were 459 such accidents last year, of which 71 per cent occurred at night, 109 caused fatalities, of which 93 or 85 4 per cent occurred during hours of darkness and 350 involved injuries, of which 233 or 66 5 per cent occurred during hours of darkness

Even when pedestrians were walking properly on the left side of the

highway facing approaching traffic there was a greater prevalence of night accidents For example, 52 7 per cent of the cases in which pedestrians were killed or injured while walking on or along the roadway properly occurred at night Of those killed while walking improperly 75 per cent were hit at night

THE VALUE OF STREET LIGHTING

Studies made by the National Safety Council in 1932 and 1933, in four States of the reporting area, showed that during the hours when it is either light or dark, in both Summer and Winter, the number of fatal accidents, hour by hour, is about the same In the evening hours, however, from 5 P M to 8 P M , when it is light in Summer but dark in Winter, the winter fatalities exceeded those during the summer months by nearly 100 per cent

Similar studies made by Mr R E Simpson, Illuminating Engineer of the National Bureau of Casualty and Surety Underwriters, (address entitled "Public Safety as Affected by Street Lighting") over a period of three years—1931, 1932 and 1933—indicate a definite relation between fatalities and non-fatal automobile accidents, Winter over Summer, and costs per capita of street lighting This study showed that as the street lighting cost per capita increases, the excess of winter fatalities decreases or, conversely, as street lighting costs per capita decrease, the excess of winter fatalities and non-fatal automobile accidents increases The conclusion Mr Simpson draws from his studies is "that the community pays for good street lighting whether it gets it or not "

Mr Simpson made a further analysis in which he compared accident experience in two groups of cities for the four evening rush hours, from 5 to 9 P M , and for the four morning rush hours, from 6 to 10 A M He found that in the group of cities which increased its street lighting budgets 11 per cent or 9 cents per capita, a decrease of night fatalities of 25 per cent was shown or an economic saving of $2 07 per capita. The other group reduced its street lighting budget by 14 per cent or 19 cents per capita and suffered a 7 6 per cent increase in night fatalities at an economic cost of 69 cents per capita

Other studies made by Mr Simpson, in which he classified various streets by the extent of vehicular traffic as well as the degree of street illumination, indicated that, in general, the night fatality rate increases as the grade of street lighting decreases He states, "Specifically, the night fatality rate per million vehicle miles on heavy traffic streets with grade A lighting is 7 times higher than the day fatality rate, 9 times higher with grade B lighting, 13 times higher with grade C lighting, and 16 times higher with grade D lighting "

He also made a study along three highways where street lighting service was turned off because of lack of funds Although these studies were not over a very long period of time, approximately 6 months, they

showed an increase in night accidents after the suspension of street lights On one roadway, when all street lights were in service, the number of night accidents per million vehicle miles was 2 87, while over the same roadway, when lights were out of service for a comparable period, the number of accidents per million vehicle miles was 7 02 On the other roadways, the number of night accidents per million vehicle miles when lights were in service was 7 54 and for a comparable period, while lights were out of service, came to 10 5

A study made in the city of St Louis where, because of an economy program, major street and parkway lighting had been decreased 33 per cent, with a 45 per cent decrease in total illumination, showed an increase of 9 per cent in night fatalities

Similar studies made in numerous other cities throughout the country where street lighting had been curtailed or increased, showed that in the case of the former there invariably followed an increase in night accidents and night fatalities, while in the case of the latter there was a resultant decrease in night accidents and fatalities

Unfortunately, reliable before and after records are not available in New Jersey to enable a determination of comparative accident experience after the installation of highway lighting Therefore, the only comparisons which may be made to indicate the usefulness of highway lighting from the standpoint of accident reduction are on roadways or portions of roadways having more or less comparable conditions, one of which is lighted to the extent of up-to-date requirements and the other is unlighted

An attempt was made in New Jersey more than a year ago to establish a series of lighting demonstration highway sections throughout the State These lighting demonstration sections were selected on the basis of night accident experience as well as other varying roadway conditions in order that the effect of highway lighting might be determined under all conditions Unfortunately, up to the present time, only two such demonstration sections have been established and although they have been in operation for more than a year, they are rather small in extent and, it is therefore not desirable at this time to offer any before and after statistics

A survey has been made, however, along portions of State Highway Routes Numbers 25 and 26, in New Jersey, one of which is properly lighted with up-to-date equipment the other having practically no lighting whatever, except at a few isolated points or intersections The lighted section comprises that portion of Route No 25 from the approaches to the Holland Tunnel to the Kearny-Newark city line, and includes the 12th Street viaduct, the depressed roadway, and a portion of the Pulaski Skyway On this highway, there are no cross vehicular movements, although there are ramps for entrances and exits permitting traffic to leave and enter Route No 25

The unlighted section of highway selected is that portion of Route No 26 taking in the Townships of South Brunswick, Plainsboro and West Windsor This is substantially the same type of highway as the lighted section, except that it is at grade There are four intersections in this area of highway It is felt that the comparison of the lighted section with this unlighted section is substantially a fair one for the reason that the majority of accidents along this portion of Route No 26 occurred between intersections As a matter of fact, only 26 of the 165 accidents in this area occurred at intersections and even in the case of intersection accidents, many of them concerned vehicles operating along the highway and did not involve vehicles on the cross streets attempting to enter or cross the highway

TABLE V

ACCIDENT EXPERIENCE ALONG PORTIONS OF STATE HIGHWAY ROUTES NUMBERS 25 AND 26, NEW JERSEY, 1933

Location	Miles of Highway	Vehicles per 24-hr day Average	Vehicle Miles			Day Accidents	Night Accidents	Day Accidents per M V M	Night Accidents per M V M
			Per Year	In Daylight per Year	At Night per Year				
Route No 25 including 12th St Viaduct Depressed roadway Part of Skyway	4 42	32,000	51,625,000	30,975,000	20,650,000	96	54	3 10	2 61
Route No 26 in South Brunswick Township	6 52	8,800	20,942,000	14,450,000	6,492,000	35	50	2 42	7 70
Route No 26 in Plainsboro Township	2 27	8,400	6,960,000	4,800,000	2,160,000	10	19	2 08	8 80
Route No 26 in West Windsor Township	3 90	8,400	11,957,000	8,247,000	3,710,000	23	28	2 79	7 55

Table V shows the results of this comparison From this table, it may be determined that along the lighted stretch of highway, namely, from the approach to the Holland Tunnel to the Kearny-Newark line, night accidents per million vehicle miles represent a 15 8 per cent decrease over day accidents, but along the unlighted portion in the Townships of South Brunswick, Plainsboro and West Windsor, night accidents per million vehicle miles, showed 218, 322 and 171 per cent increases, respectively, over day accidents

Although a comparison such as this might be said to be unfair as it does not represent the before and after conditions of the same roadway,

it is felt that this one is proper as practically the same type of vehicular traffic traverses each of the portions of highways selected, with the exception that the extent of use is somewhat greater over the lighted area The difference in volume of vehicular traffic over each of the sections has been taken care of, however, by basing the analysis on vehicle miles, rather than on miles of highway Also, as stated before, the two portions of roadway are somewhat comparable with respect to the extent of cross traffic However, on the unlighted section of highway in the Townships of South Brunswick, Plainsboro and West Windsor, there is an additional hazard caused by pedestrians walking on or along the roadway which is not included in the lighted section This hazard exists only on the unlighted stretch of roadway for the reason that the lighted section included in the comparison is either above or below grade and, therefore, is not subjected to pedestrian traffic However, the inclusion of the pedestrian hazard in this comparison, even though it exists in one case and not in the other, further accentuates the hazard of darkness

THE IMPORTANCE OF SEEING

The need for seeing on the highway has not been given due consideration in the past Whether by day or night, seeing, in order to provide safety, must be done quickly and with certainty Time intervals of less than one second duration may mean the difference between life or death The past decade has seen the birth of a new science—The Science of Seeing—which is now affording a new approach to highway safety We now are able to obtain a new conception of visibility, which shows a definite need for greater factors of safety Today, we realize that the eye is but a tool to be combined with light and lighting, that the human being as a seeing machine has certain definite limitations which, when not taken into account, materially increase the toll of traffic accidents

In the past, the engineer has interpreted vision and visibility in the customary manner but now we realize that "SEEING is the total act of recognizing objects It involves the so-called visibility of the object and the capability and sense capacity of the human seeing machine This yields a new conception of visibility because this must deal with more than the physical characteristics of the object and its background, such as size, color and brightness Visibility of an object must also include the ability of the human seeing machine, which in turn involves obvious factors, such as eyes and time and less obvious ones, such as distractions, available sense capacity, bodily, neural and mental states " (Dr Mathew Luckiesh in "Seeing and Highway Safety ")

The engineer, in the past, has generally considered only controllable factors such as objects, backgrounds, light and lighting These factors are part of the external physical realm Size of critical detail, contrast

in brightness and color between the object and background, the brightness of the object or its immediate background, and the time available for seeing, also directly influence the visibility of an object In addition, there are many other external factors which in the past have not been given consideration and yet which affect the efficiency of the human seeing machine These factors may be classed as distractions, such as extraneous noises, conversation, activities necessary in driving an automobile, and general backgrounds of varying patterns, brightnesses and colors Considering all of these distractions, the sense capacity of the driver available for safe driving is reduced, which in turn reduces the ability of the human seeing machine and thereby decreases the visibility of the object

Realizing that the human being is a seeing machine and as such is subject to internal losses, we find that seeing as an activity drains human resources In the past, we have thought that seeing was but an activity of the eye but recent researches have proven that there are wastes of energy through muscular, neural and mental channels Nerve and muscular tension are increased, heart action is decreased In fact, the act of seeing has its effect upon the entire body

Living as we do in an era of high speed, unrest, heavy traffic, seeing upon our streets and highways carries a great responsibility, made heavier through inadequate light and improper lighting encountered in night driving We are undoubtedly familiar with the burden that this responsibility places upon us and realize this burden through experience of fatigue upon the completion of a motor trip at night but do not realize that adequate street lighting will decrease this burden The greatest fatigue occurs when combatting a fog, a drizzling rain or heavy traffic upon wet roads Although the actual work necessary to steer and control the car has been no greater than that expended when driving over the same route in the daytime, our bodily and mental fatigue are immeasurably greater

Considering the speeds which we encounter or which we ourselves practice in present-day driving, available time for seeing is an element that must be carefully considered At low intensities of light on the highways at night, speed of seeing is materially decreased over that encountered in daytime seeing

Every factor which increases visibility also increases the speed and certainty of seeing At very low levels of brightness, the eyes, the visual sense, and the human seeing machine are in a different state than at higher levels where greater safety is made possible

THE ECONOMY OF STREET LIGHTING

Evidence has previously been given proving the street lighting bears an important economic relation to motor vehicle accidents To this evidence may be added the following.

Table V, shows a reduction of night accidents over day accidents when highways or portions of highways are adequately lighted as against a decided increase in night accidents over day accidents when highways are insufficiently lighted or not lighted at all

The lighted section of State Highway Route No 25 included in the study shown in Table V, requires an expenditure of $23,691 per year If it is assumed that adequate lighting had not been provided along this portion of the highway and that therefore, the excess in night accidents would be comparable to the average excess of the three portions of Route No 26 shown in Table V, and using a figure of $1,000 as the economic loss for each accident, it is found that there would have been a loss of $78,000

It is considered that such an analysis is entirely fair as, in all probability, if lighting had not been provided along the lighted portion of Route No 25, there would have been a greater excess of night accidents to day accidents than shown on Table V for Route No 26, because of the fact that there is a greater concentration of night traffic on this section of Route No 25 than on the sections of Route No 26 used Also, the economic loss of $1,000 per accident is considered a conservative figure It is based upon estimates of actuaries and statisticians of insurance companies using average earnings as life annuities for those persons killed and actual losses because of paid claims for persons injured and property damage losses

If the previous analysis is reversed, and it is assumed that the three sections of Route No 26 shown in Table V were adequately lighted and, consequently, the excess in night accidents over day accidents decreased comparable to the ratio for the lighted section of Route No 25, it is found that there would have been an economic saving of nearly $40,000 after deducting the cost of lighting This saving is based upon an economic loss due to motor vehicle accidents of $1,000 per accident and a cost of $1,500 per mile of highway to light adequately the portions of Route No 26 indicated

The difference of approximately $4,000 per mile for the cost of lighting the now unlighted road and that of the lighted road is explained by the differences in lighting requirements due to type of roadway, density of traffic, etc

CONCLUSIONS

It may be seen from all of the foregoing that there is a definite relationship between highway lighting and highway accidents and that, in general, where adequate lighting is provided, there is a substantial reduction in night accidents This reduction in night accidents results in economic saving in excess of the cost of providing street lighting Without mentioning, the suffering and sorrow which inevitably accompany motor vehicle accidents

Sufficient and proper illumination for night driving can only be attained by two methods, adequate and properly adjusted and used headlights and up-to-date street and highway lighting The science of automobile headlighting is improving and with the newly-adopted multiple beam headlights, it is possible, under favorable conditions, to provide illumination far enough in advance in order to give drivers adequate vision for safety at high rates of speed However, because of the volume of traffic normally using major highways, such headlight illumination makes it necessary that the clear road beam be frequently depressed so as not to cause excessive glare to opposing drivers Oftentimes, because of negligence or carelessness, drivers fail to depress the clear road beam and, consequently, create a momentary blinding of drivers approaching from the opposite direction

With highway lighting, the principle of vision by silhouette is employed so that beam candle powers necessary for headlights need not be used In addition, the light source may be placed high enough from the roadway to be out of direct line of vision of drivers It may be placed over the travelable portion of the roadway, providing a continuous path of light even in times of inclement weather Also, maintenance of a street lighting system is in the hands of but a few trained men as compared with the maintenance of individual lighting systems on hundreds of thousands of automobiles

It is true that proper and sufficient highway lighting appears costly However, the expense of properly lighted highways compared with the benefits derived, including saving of lives and savings of millions of dollars, all of which is a part of the tremendous economic loss, shows a saving of monies to the taxpayer who must ultimately foot the bill in either case

DISCUSSION—RELATION OF HIGHWAY LIGHTING TO ACCIDENTS

Mr C S Pope, *California Division of Highways* I think the increased capacity of highways through lighting is going to come more and more into prominence in highway work There are many locations in this State where lighting is going to be a major problem within a few years because of the heavy night use of highways The economics of constructing additional lanes of highways to care for intenes traffic during the daytime or for making a somewhat lower expenditure for lighting which would allow a greater number of hours of safe use of the highways will, no doubt, engage the attention of highway engineers from now on