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TRANSPORTATION RESEARCH CIRCULAR

Number 210, September 1979
ISSN 0097-8515

Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418

RESEARCH PROBLEM STATEMENTS

mode
1 highway transportation

subject areas
21 facilities design
54 operations and traffic control

OPERATION AND MAINTENANCE OF TRANSPORTATION FACILITIES

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INTRODUCTION

Committee A3A08, Operational Effects of Geometrics, has engaged in an activity which its membership believes is one of its several major charges, that of identifying research needs and communicating them to the transportation research community. The committee has previously evaluated and published research problem statements, and the publication of this Circular is a continuation of that activity.

ANALYSIS METHOD

As in the previous evaluation, the committee employed the Delphi technique which utilizes the feedback of opinions of the evaluators and depends on iterations of the evaluation process to produce a convergence of opinion. Two iterations were employed in the current evaluation. In each iteration, the individual committee members were instructed to evaluate each of eight research problem statements for absolute rank, to allocate hypothetical research funds from a total research budget which was not to be exceeded, to assess the probability of success on a one-to-one-hundred percent basis, and to briefly provide the rationale for each evaluation. There were actually ten problem statements initially but in two cases, two statements were combined because they dealt with the same problem area.

The results were summarized such that anonymity was maintained. In each iteration, twenty-four committee members were sent the evaluation materials; however, mail problems, changes in professional assignments, other committee assignments, and other phenomena produced only eight respondents during the first iteration. In the second iteration, there were 15 respondents, all of whom had the results from the first iteration evaluation.

EVALUATION RESULTS

Results of the second iteration evaluation were essentially the same as those from the initial iteration evaluation. Only the lowest two ranked problem statements had their rank position altered during the second evaluation. Further, the assessed probability of success was altered very little for the top ranked problem statements. The greatest shift took place in the allocation of hypothetical research funds to each problem statement. In both iterations, most dollars were allocated to the two top ranked problem statements. However, during the second iteration, 19 percent more dollars were allocated to the top ranked statement than during the first iteration and 24 percent fewer dollars to the second ranked statement.

Of the eight problem statements ranked, two are considered high priority, two as moderate priority and the remainder as low priority. The tabulation below summarizes the results of the evaluation. This is followed by a discussion of each of the high and moderately rated problem areas. Each discussion briefly states the nature of the problem, the objectives and scope of the proposed research, the estimated cost and time needed to complete the research, and a closing statement on why it is urgent that the research be completed.

Priority Category	Problem Statement Number	Title
High	1	Approach to Roadside Safety on Two-Lane Non Freeways
High	2	Operational Effects of Reduced Geometry in Freeway Construction and Work Areas
Moderate	3	Optimum Median Width for Rural and Suburban Expressways
Moderate	4	Cost Effectiveness of Providing Skid Resistant Surfaces on All Bituminous Overlay Improvements
Low	5	Cost Effectiveness of Widening Narrow Bridges
Low	6	Criteria for Design and Use of Temporary Barriers
Low	7	Cost Effectiveness Comparison of Railroad Grade Crossing Traffic Control Device Improvements Versus Replacement of Rough Crossing Surfaces
Low	8	Operational Effects of Class II and Class III Bikeways on Urban Streets

PROBLEM NO. 1: APPROACH TO ROADSIDE SAFETY ON TWO-LANE NON-FREEWAYS

The concept of maintaining a 30-foot clear zone along freeways is well established. There is a need also to provide some degree of roadside safety along two-lane non-freeways. However, there seems to be a general concensus that the 30-foot clear zone concept is not a cost effective approach for rural two-lane highways. Studies have shown that the number of objects hit by vehicles running off the roadway decreases drastically as the lateral distance of encroachment increases. Furthermore, the location of obstacles in relationship to alignment (i.e., a tree located on the outside of a curve vs. one on the inside of the curve) affect the accident potential. Consequently, there are various factors that affect the cost effectiveness of removing or modifying roadside obstacles such as trees, culverts, guardrails, and headwalls. Because of the expense associated with such measures, their cost effectiveness on two-lane highways with narrow shoulders and other alignment deficiences is highly questionable.

NCHRP Report 148, "Roadside Safety Improvement Programs on Freeways," deals with a cost effectiveness priority approach to this subject for freeways. Report No. FHWA-RD-75-23, "Effectiveness of Roadside Safety Improvements," deals with roadside safety improvements on non-freeways. However, it is concluded within the report that further research is needed to develop hazard-sensitive site-specific information.

Research Proposed

The objectives of the proposed research should be:

1. To develop a cause and effect relationship between the lateral location of roadside obstacles, geometrics of the adjacent roadway, operating speeds, and accident occurrence and severity for two-lane rural highways.

2. To determine the cost effectiveness of measures for removal or modification of roadside obstacles along two-lane rural highways with different geometric characteristics.

3. Provide procedures and/or recommendations for highway agencies to use in determining the types and locations of roadside obstacles that should be removed or modified along various functional type rural two-lane highways.

4. Determine the desirable clear zone width for various types of alignment that should be provided for two-lane reconstruction projects utilizing existing right-of-way.

Scope: This research should build upon that reported in Report No. FHWA-RD-75-23. It should consider roadways with varying horizontal curvatures, lane widths, shoulder widths, right-of-way widths, roadside terrain, and traffic volume and mix. All types of roadside obstacles should be considered including different diameter trees, ditch treatments, manmade objects, etc. The following three types of roadside treatment should be considered: removal of an obstacle or making it break away, moving the obstacle farther from the traveled-way, and providing protection (e.g., guardrail) to shield the obstacle. Cost elements should include both capital and maintenance costs where applicable (e.g., purchase of additional right-of-way or guardrail, maintaining damaged guardrail, etc.).

The research should produce a concise users manual that can be easily employed by those responsible for deployment of funds and design for upgrading of our rural two-lane highway system. Procedures set forth in the manual should not require input data which is not readily available or is too costly to obtain.

Problem Estimate

Estimated Cost - $125,000
Study Period - 1½ years

Urgency

With the combining of Federal funding for high hazard locations (Section 168 of the Federal-aid Highway Act of 1978) and the elimination of roadside obstacles, highway agencies must make decisions regarding the use of these limited funds without the benefit of having procedures to permit a priority approach.

PROBLEM NO. 2: OPERATIONAL EFFECTS OF REDUCED GEOMETRY IN FREEWAY CONSTRUCTION AND WORK AREAS

Maintenance and rehabilitation are continual requirements of the nation's roadway system. These processes have been accentuated in recent years for the national Interstate System as more and more freeways constructed early in the Interstate Program are rapidly approaching the limits of their initial service life. Moreover, the continuing reduction of new highway construction in urban areas has renewed interest in maintenance, reconditioning, and operations of the existing roadway system.

Traffic engineers have an obligation to provide for the safe and efficient flow of traffic through or around work areas while maintaining an adequate and safe working environment for the maintenance employee or contractor performing the work. Often, the control of traffic through construction and work areas on freeways requires a reduction in geometric standards during the work activities. Reduced lane widths, shoulder widths, acceleration ramp lengths, deceleration ramp lengths, sight distance, etc., are common practices during freeway construction projects. The high travel speeds and high traffic volumes generally found on freeways impose special problems in providing adequate measures for smooth traffic operations during construction activities. The adverse effects of reduced geometric standards in freeway construction areas can be very costly and hazardous. Therefore, a considerable amount of analysis is necessary in the project planning stage to arrive at a safe and efficient plan for the maintenance and protection of traffic.

Since there is considerable variation in the geometrics involved in freeway construction and work areas, the engineer must, in the conceptual stage of planning, evaluate various alternative geometric and traffic control schemes in terms of their potential effects on traffic flow and safety. For this analysis, the engineer has little to assist him/her other than his/her past engineering experience and the Highway Capacity Manual. But, the Highway Capacity Manual is relatively old and is presently being updated. Furthermore, the manual does not specifically include a procedure for estimating work area capacity and level of service for various work area geometrics and traffic demands. Work area capacity and level of service must be estimated using procedures developed for freeways, ramps, etc. operating under "normal" traffic flow conditions.

Specific procedures should be developed to estimate work area capacity and levels of service and safety based on work area geometrics and traffic demands. In addition, standard practices and minimum geometric standards should be developed for freeway construction and work areas for the guidance of designers, contractors, traffic engineers, and maintenance and other appropriate personnel.

Research Proposed

The objectives of this research should be to:

1. Review and summarize present practices on employment of reduced geometric standards for freeway construction and work areas; e.g., reduced lane widths, sharp curvature usage in crossovers, restricted lateral clearance, reduced ramp entrance facilities, etc.

2. Review and evaluate the operational effects of reduced geometric standards in freeway construction and work areas.

3. Develop recommended geometric standards for freeway construction and work areas.

Scope: Several areas related to work area traffic flow under restricted geometric conditions need to be investigated. For example, do the lateral clearance factors given in the Highway Capacity Manual apply to typical work area traffic control devices such as drums, barricades, cones, etc.? Specific procedures should be developed to determine capacity and level of service at lane closures for varying approach volumes, percentages of trucks, grades, lengths and angles of taper, type of merge (left or right merge), etc. Crossovers should be studied to determine their capacities for varying geometric features. How the severity of pavement dropoffs affect lateral placement and speed also needs examination. When can a short freeway entrance facility with yield sign be used? This is a problem when the outside freeway lane is closed. All of these questions need to be studied under varying climatic, visibility, and working type conditions. Further, in answering the questions, procedures should be established and used to estimate queuing, travel time, and delay effects of reduced geometrics.

This research should provide procedures and factors for determining the capacity and level of service of work zones with reduced geometrics and should establish minimum geometric standards that should be used for various work activities and traffic demand conditions.

Problem Estimate

Estimated Cost - $300,000
Study Period - 2 years

Urgency

This study should be given high priority because many State highway agencies are involved with major work on existing freeways and the traffic control has become a very critical item. Currently, there is major national emphasis on traffic control in work areas and this study would provide needed answers to some of the problems faced by traffic control personnel involved with freeway work areas. Improvements in the maintenance and protection of traffic through freeway work areas are essential at the earliest date because of increased public awareness, liability, operating costs, etc.

PROBLEM NO. 3: OPTIMUM MEDIAN WIDTH FOR RURAL AND SUBURBAN EXPRESSWAYS

Experience has shown that at-grade intersections with expressways having wide (over 30' but especially over 60') medians have posed various operational problems. Of particular concern are the problems of handling left turns from the expressway at signalized intersections and cross or left turning traffic from minor facilities at non-signalized intersections with no control on the expressway.

In the first case, problems have been experienced in keeping the left turning motorist from stopping within the intersection upon seeing apparently conflicting signal indications and in providing sufficient clearance time to permit slow-moving left turning vehicles to safely cross the opposing lanes. Channelized (shadowed) left-turn lanes have proved beneficial in reducing the distance through which the left-turning vehicle has to turn. Optically programmed signals can eliminate conflicting indications but passing through a "blank" signal can cause some confusion.

The second problem is that of stopping a crossing or turning vehicle in the wide median. Stop signs can be placed in very wide medians to require crossing in two steps. However, there usually is insufficient room for more than one vehicle, which restricts the cross flow. Often, a second motorist anticipates the movement of a vehicle stopped in the median and starts to cross. If the vehicle in the median does not cross, the second vehicle enters the median and restricts the chances either vehicle has of completing the crossing or turning and blocks any cross flow in the opposite direction.

Research Proposed

Research is needed to:

1. Determine the optimum median width for expressways, so as to provide good operation between intersections, desirably without the need for median barriers.

2. Determine what median width should be used at both signalized and non-signalized expressway intersections so as to provide safe, uncomplicated traffic operation.

Scope: Expressways in both rural and urban areas, where operating speeds vary considerably, should be studied. Both traffic volume and mix operating along the expressway and on intersecting side streets and roads must be considered, particularly those which are making left-turns from the expressway and those crossing or making left-turns from the side streets and roads. Tractors which are quite long and which have poor acceleration characteristics can drastically affect operations at expressway intersections with varying median widths. Gap availability, type of anticipated intersection control, available sight distance, need for left-turn bays, etc. are other parameters which could affect what median width should be used at expressway intersections. Similarly, the amount and type of roadside businesses can affect how many vehicles may desire to turn left and should, therefore, be considered.

Problem Estimate

Estimated Cost - $175,000
Study Period - 1½ years

Urgency

This research is important since multi-lane roadways which are divided and have no or only partially controlled access typically experience very high accident rates. For example, in 1977 the accident and injury rates on six-lane uncontrolled and partially controlled access routes in Virginia were double the rates on their two-lane highways. Similarly, California's accident rate on four or more divided lanes with no access control was 4.73 accidents per million vehicle-miles in 1969 while the rate was only 2.83 on their two-lane highways.

PROBLEM NO. 4: COST EFFECTIVENESS OF PROVIDING SKID RESISTANT SURFACES ON ALL BITUMINOUS OVERLAY IMPROVEMENTS

Skid resistant surface courses are currently required on Federal-aid projects along entire sections of roadway being improved with bituminous overlays. An alternate regulation would require such surface courses only at specific locations where there is a high potential for accidents due to existing geometrics; e.g., curves, intersection approaches, etc. Skid resistant surfaces are relatively expensive when local aggregates do not provide the necessary skid resistance qualities and other aggregates must be transported from distant sources.

A determination should be made as to whether the additional cost of providing skid resistant treatment to the entire length of a roadway section being resurfaced is actually justified by reductions in accident numbers and severity, or is it cost effective to provide this treatment only at specific locations with high skid resistance demands.

Research Proposed

The objectives of this research would be to:

1. Develop procedures for evaluating the cost effectiveness of skid resistant surfaces taking into account geographical differences in climatic conditions.

2. Determine, utilizing the procedures developed in objective 1, if it is cost effective to provide skid resistant treatment only at selected locations along a resurfacing section or to provide the skid resistant treatment to the entire length of the roadway section being resurfaced.

Scope: This research can primarily be accomplished through mathematical analytical techniques. Using traffic volume, speed distribution and environmental data together with established friction coefficients for skid resistant surface treatments, known coefficient of friction/speed/accident relationships, and speed/accident severity relationships, the probability of accidents and the degree of their severity should be able to be computed for different surface treatments under varying geometric and traffic operational conditions. This information, coupled with costs for providing the skid resistant surfaces, can then be used to establish thresholds where skid resistant treatments should and should not be used. The research should provide simple step-by-step procedures for making the above analyses. Such procedures should require data that is readily available in a State Highway Organization and should permit different weighting of factors used in the analysis; e.g., cost of aggregates used in the treatments.

Problem Estimate

Estimated Cost - $100,000
Study Period - 1 year

Urgency

Results of this research could be effectively utilized in allocation of funds for 3R type improvements.