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## THE URBAN FREEWAY IN TEXAS

by

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I am convinced that the urban freeway has had more of an impact upon our communities than anything else in recent years. If we consider both construction and user cost, urban freeways have the lowest combined travel cost of any type of roadway. It has been reported recently that in Los Angeles, Orange and Ventura Counties, California, a saving of 85 million in operating cost, 60-1/2 million in accident cost and 275 million in time savings take place annually. There are many other documented examples of user benefits afforded by urban freeways.

I believe the "vote" that is being cast by each driver using the freeway is indicative of their importance.

In talking about freeways and especially here in Texas, I believe it would be of interest to look back on the evaluation of our system. It would be interesting to see where we have been, where we are now, and where we are going. Some of you may have heard me refer to this development as first, second, and third generation freeways. I believe this classification is still valid and a quick look at them might be in order.

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Our first generation freeways came into reality soon after World War II. (1) The Gulf Freeway in Houston was probably the first in Texas. (2) The Dallas Central Expressway was also among the first. Then, of course, other first generation freeways were built in Fort Worth, San Antonio, El Paso and Austin. We actually had very little background information, experience or design criteria on which to develop these early facilities. We had little knowledge concerning speeds, driver characteristics, theories of traffic flow, wheel loads, etc. (3) These freeways had several things in common. They had a narrow, curbed median, usually only four lanes, some with shoulders and some without. (4) These facilities usually had "roller coaster" grade lines, poor lane alignment, ramps were poorly designed and, in general, full of surprises, (5) weaving sections were extremely short in many cases, but I guess the most frustrating thing is that they were built to be the final and ultimate facility. (6) No provision was made either in the right of way acquisition or the design features to allow for an economical future expansion. Actually, it is amazing that these facilities are still functioning as well as they are. We have a relatively good accident rate in spite of all these deficiencies. (7) Through refined traffic engineering,

or sometimes its called "fine tuning", we have been able to remove accident contributing elements as well as improve the flow of traffic. Our Level of Service research project on the Gulf Freeway has made quite a contribution along these lines. I hope to say more about this study later on.

(8) Roadside obstructions, obviously more prevalent on earlier facilities, have a tendency to contribute to higher accident rates. We have plans to eliminate as many of these obstructions as possible.

The transition from the first to the second generation freeway, of course, is not a clearly defined evolution. Since 1956, in developing the Interstate System, we have continually improved our design concepts and practices.

(9) As our traffic projection techniques improved, we became concerned with the capacity of our facilities. So, in defining our second generation freeway, we might say that it evolved as a result of a need for our design to accomodate increasing traffic volumes. In this new generation we provided, not in all cases but in most, adequate lanes to take care of at least 15 to 20 years of projected traffic volumes. Here are some other pictures which show some of our second generation freeways. (10) Here is one with six lanes, (11) one with eight lanes, and (12) ten lanes.

We can also see here some typical design changes. (13) We have wider medians, better grade lines, better alignment, more adequate shoulders, crown width bridges, smooth flowing ramp designs and more thought given in the design stage to signing and traffic control problems. (14) More sophisticated interchange designs emerged including the replacement of the cloverleaf with the full directional.

(15) From research and experience, we have learned much in the last few years -- much about traffic flow, pavement design, bridge design, access control and ways and means to make our highways safer. In our second generation facilities, we have incorporated many aspects of this new technology into our design. Actually, in several instances, design-wise, we have broken our shell and have seen an emergence of the third generation freeway. If we could provide a definition, it might go something like this, "It should be a facility concerned with handling, during peak hours, larger volumes of traffic at reasonable speeds and moderate to low volumes at extremely high speeds, all under the safest possible conditions."

(16) As close as the automobile industry guards their secrets of future vehicle designs, it is almost impossible for us to know what to expect; however, if today's speeds are any indication at all, then it is my opinion that future

urban freeways should be designed for speeds of 70 to 80 miles per hour. In connection with these newer facilities there are at least three main objectives or considerations that are in the mind of most of our highway planners and designers today:

1. To design capacity and adequacy into the facilities and to insure its compatability with the total highway-street system.

2. To insure maximum safety to the highway user at the design speeds.

3. Then, one that we have too often been criticized for not considering and, I believe perhaps unjustly, is to adequately plan, study and consider the facility and its interface with and compatability to the community which it serves. Let us talk about this last one first, then we will go back and examine the other two. This would include considerations of economic factors and human factors. The location and design of our facilities have a tremendous effect upon the improvement and economic development of the urban area. The driving habits, indirections and other human factors are being brought into the picture.

Double-decking of existing freeways and new elevated freeways through built-up urban areas will be forthcoming for many Texas cities.

The noise emission problems, architectural treatments, emergency vehicle call systems, freeway surveillance and many other factors are being considered in connection with these new freeways.

In response to some of our critics, and I don't mean to belabor this point, but may I say that the highway engineers in the past have given more attention to some of these considerations than for which they have been given credit. You know, it is difficult for many people to remember "before" and "after" conditions. (17) This is what the Central Expressway in Dallas looks like today. (18) here is a picture of the right of way before the Central Expressway was built. Few people now remember how this looked. The Gulf Freeway in Houston and many other "before" conditions looked almost as (19) bad. Really, many of our freeways were urban renewal projects within themselves, and of course, new developments, investments, and improvements followed each project upon completion.

(20) The impact of freeways on urban areas is almost unbelievable. We have made a very extended effort here in Texas to provide the maximum in local service. Numerous exit and entrance ramps, interchanges, and frontage roads all bear witness to this consideration and no doubt in some cases, even to the detriment of the facility's operation.

Public and private schools, public parks and recreational areas, hospitals and such, together with the general conservation of natural resources, have always received special attention in our planning and location studies and they will continue to be a major concern. I make these remarks because many of our freeways of the future must be compatible with highly developed industrial, commercial and residential areas. Very seldom do we have highway right of way locations available now like that for Central Expressway.

(21) If I may, I would like to return to our No. 1 design consideration and that is, to design capacity and adequacy into the facility. The level of service concept as outlined in the capacity manual provides us with a good guide to examine the traffic carrying capabilities which our freeway design should contain. Actually, in the schematic stage, each freeway design and each component part of the geometrics are analyzed to see that we are providing the level of service suitable for the design year. We carefully examine parts to see that they will not be creating a bottle-neck in the total system.

We are now in the process of developing a computer program to assist us in these investigations. As you may know, the capacity of a highway is a measure of its ability to serve traffic.

It is further defined as the maximum number of vehicles which has reasonable expectation of passing over a given section of highway during a given time period under prevailing roadway and traffic conditions. Prevailing conditions "may be divided into two groups: (22) (1) those that are established by the physical features of the roadway (grade, horizontal alignment, lane width, clearance to obstructions, etc.), and (23) (2) those that are dependent upon the nature of traffic on the roadway."

Level of service is a qualitative measure of the effect of a number of factors affecting capacity which includes speed, travel time, traffic interruptions, freedom to maneuver, safety, driving comfort, and convenience of operation cost. Specific levels of service range from the ideal operations, (referred to as Level "A"), to complete congestion (referred to as Level "F").

I have some slides here that might give you some idea of what traffic looks like at various levels of service.

(24) Level of Service "A" describes a condition of free flow, with low service volumes in the range of 1,400 passenger cars per hour total for two lanes in one direction under ideal conditions.

(25) Level of Service "B" is the higher speed range of stable flow. For freeways and expressways, it is defined by

the requirement that operating speeds be at or greater than 55 miles per hour.

(26) Level of Service "C" - In general, the requirements for Level of Service "C" are an operating speed of at least 50 miles per hour.

(27) Level of Service "D" is in the lower speed range of stable flow with volumes higher than those found in Level "C", traffic operation approaches instability and becomes very susceptible to changing operating conditions.

(28) Level of Service "E" is the area of unstable flow, involving over-all operating speeds of about 30-35 miles per hour and involving volumes approaching 100% of capacity, or about 2,000 passenger cars per lane per hour under ideal conditions.

(29) Level of Service "F" describes a forced flow condition in which the freeway acts as storage for vehicles backed up from a downstream bottle-neck.

(30) Let us go back now to consider the No. 2 objective in design. As you will recall, it was to insure maximum safety to the highway user at the design speed. You may have heard this statement before; however, we believe that it is true and worth repeating, "Safety is a by-product of good and proper design."

For example: (31) A well designed ramp will provide safety to the user. A weaving section or a merging section that is adequately designed will have a low accident rate. This "spin-off" comes only when we know and practice good design. However, aside from these general design features, we have made a concerted effort to discover the elements that are causing accidents and try to take corrective measures. Much of our research is aimed in this direction. (32) The Texas' break-away sign supports have attained nationwide acceptance. (33) Frangible bases for our light poles, flatter side slopes, crown width structures, and (34) median guard fence (and this perhaps has been the greatest single contribution to freeway safety in urban areas) are all examples of our efforts to make the highway safer. (35) Pavement surfaces to prevent skidding and hydroplaning are being studied. This picture shows our new skid measuring equipment.

(36) Our Gulf Freeway Level of Service study is probably the greatest single research effort that has ever been made to study freeway operations. (37) The development of automatic ramp metering equipment, the 14-camera T.V. Surveillance system, the development of merging criteria and other design criteria are a few of the accomplishments. Many reports have been published.

Traffic accidents alone have been reduced approximately 50 per cent on that portion being controlled. Suppose we look at a few more pictures:

(38) This shows the location of a T.V. camera on top of the light standard.

(39) Another view of T.V. screens and the monitor.

(40) These are controllers for the automatic ramp metering equipment.

(41) This IBM 1800 belongs to the Bureau of Public Roads. As soon as interface equipment is installed, this type of equipment will be evaluated.

(42) This is a picture of the plotter.

(43) Here is an entrance ramp; notice the merge "loop" detector.

(44) This shows the signal and additional loop detectors.

(45) Loop detectors upstream on the main lanes.

(46) I'll show you here a series of slides taken off the T.V. monitor (the light is red for the truck on the right).

(47) The light turns green to release the truck and quickly turns red again to hold the following automobile.

(48) The truck is arriving in the merge area.

(49) Here it merges into the gap.

(50) It is in the traffic stream and now we see the second vehicle merging.

(51) Stalled vehicles have a big influence on traffic flow -- even when they are parked on the shoulder area.

(52) Here we can see a stalled vehicle. The upstream traffic is moving very slow with little or no headspace -- a level of service of about "F". On this side or downstream, congestion is relieved and improved flow is taking place. If we could see the other pictures downstream, we could see that the traffic is flowing much more freely -- perhaps even level of service of "C" or "D".

(53) Raphael, one of the greatest artists of the Italian Renaissance, was asked which one of his many paintings he thought was the best. He replied, "My next one!" This is somewhat the way we feel about our freeways. We are never completely satisfied. We think that our future freeways will be the best. We still are in the learning process. We need to re-examine much of our design criteria. Design policies and guides have not been able to keep pace with our programs; however, I believe that we are making headway in this direction.

I would like to take my remaining time, if I have any, to talk about the Traffic Operations Program to Increase Capacity and Safety.

Most of you all know this by the acronym, "TOPICS". As you know, this program has the dual purpose of relieving traffic congestion and the promotion of highway safety in cities.

The TOPICS program involves the expansion of the Federal-aid Primary System to include principle streets and downtown grid systems in areas of 5,000 or more population. Certain kinds of engineering improvements would be eligible for Federal-aid under this program. Major construction is not included, but improvements of traffic operation which can step up speeds on urban traffic arterials are the major consideration. TOPICS may involve such improvements as channelizing intersections, added approach lanes to signalizing intersections, left turn slots, traffic control systems, separate bus lanes, reverse directional lanes, improved truck and bus loading stations, and similar items. These are all good, desirable and much needed features.

I am sure that most of you here would like to know what the Highway Department's policy will be in regard to TOPICS. Perhaps I can elaborate on our position.

First, it is apparent to us that this program cannot be, in any manner, a substitute for the much needed new freeways and other major urban arterials already on the Federal-aid system

that must be built within the next few years if we ever hope to keep pace with the expanding urbanization and increase in traffic.

Second, many of the improvements covered by the TOPICS program are being accomplished under our Highway Safety and Betterment Program utilizing State funds. Therefore, at this time it would appear to the Department that due to the limitations of this program we would not be justified in reducing our normal construction programs to accomodate the improvements contemplated by the TOPICS program. Nevertheless, we will give careful consideration to any suggested improvement that qualifies under the TOPICS program that is now on a designated state route. Further, we have noted with interest that many improvements included under the TOPICS Program are also included in the Highway Safety Program under the jurisdiction of the Governor. The Highway Safety Program is a funded program separate from the Highway Trust Fund, and several cities have already made application for funds to improve their traffic operation and enhance safety. In summary, we believe that the objectives of the TOPICS program are good; however, we do not believe that a reduction in our normal construction program in the urban areas in order to provide these improvements under the TOPICS program would be to the cities advantage.

Perhaps as a result of pilot projects in the TOPICS program, the public will see what can be accomplished with low to medium priced traffic operational improvements and see to it that new financing is made available. If and when new Federal funds might become available for this work, I am sure that the Highway Department would be pleased to take a second look at our position in the matter.