

area out further from the mainline wheelpaths. Edge-striping is used to help retain traffic in the pavement area. Experience soon showed that the 3-inch thickness was not sufficient to serve without early distress, and this thickness was increased to 6 inches, which appears adequate.

## SHOULDER PRACTICES AND PERFORMANCE IN TEXAS

John F. Nixon, Texas Highway Department

Since 1954, when traffic volumes justify, it has been a general policy of the Texas Highway Department to provide wide paved shoulders wherever possible. Specifically, the policy requires that two-lane facilities with an existing ADT of 1,000 vehicles or more be constructed with either 13-foot lanes and 9-foot paved shoulders or 12-foot lanes with 10-foot paved shoulders.

On Interstate Highways where Federal-aid participation is limited to paving only 4 feet of the inside shoulder, it has been the Texas practice to pave an additional 2 feet of shoulder with State funds to provide 6 feet of paved interior shoulder. On divided highways where shoulder paving is eligible for Federal-aid participation, the State has always practiced paving the entire 10-foot outside shoulder and the entire width of the inside shoulder.

In addition, to reduce the hazardous transition at approach guardrail installations and structures, Texas has encouraged the use of crown-width bridge structures which provide full shoulders plus offset for continuous guard fence installations. Thus, a two-lane roadway with 12-foot lanes would have two 10-foot shoulders, each with an additional 2-foot offset to yield a clear roadway width of 48-feet across structures. On a divided four-lane facility, a 6-foot inside shoulder and a 10-foot outside shoulder are provided with an additional 2-foot offset on the outside shoulder for the positioning of continuous guard-rail producing a crown width total of 42 feet.

Until recently the use of edge striping to delineate the edge of the pavement has been used very rarely in the State. Instead, the shoulder has been differentiated by the use of aggregate with contrasting color and texture. The construction of shoulders in Texas employs the same structural section as do the main lanes. Supplemental benefits derived from the full depth shoulder section are:

1. It enables two-lane facilities, which through the years have become congested and unable to accommodate the increase in traffic volumes to be very simply converted to four-lane facilities. With a seal coat application or overlay and lane striping, the two-lane road is transformed into what is commonly referred to as a four-lane "poorboy" design.

2. It enables the shoulder to be used intermittently by slow moving vehicles to allow faster vehicles an opportunity to overtake and pass. Through the years this courtesy has become widespread in rural areas of Texas and has gained legal acceptance.

On multi-lane facilities use of the shoulder by slow-moving vehicles is discouraged and this is accomplished by signing, contrasting color and texture, and other methods. As a result, the State has had very little difficulty with traffic misusing shoulders on divided highways.

It is felt that one of the greatest achievements accomplished in shoulder design in Texas in the past 20 years has been the provision of uniform width, all weather type shoulders on primary highways. There is perhaps no other single design aspect of the Texas Highway System which has received such wide acclaim by the travelling public.

#### CONFERENCE SUMMARY

John W. Hutchinson, University of Kentucky

In summary, a need has been shown for 1) construction of full depth monolithic pavements throughout the entire width of the shoulder area so as to avoid the costly problem of maintaining a longitudinal joint just outside the right-hand edge line, 2) eliminating the "drop-off" or "raised shoulder" at the right hand pavement edge and 3) eliminating shoulder structural distress due to traffic loadings.

The preceding needs are supported by the frequent use made of the first foot of width of the shoulder just outside the pavement edge; California actually uses the entire shoulder as a designated through traffic lane during rush hours in Los Angeles, and has done so for years. Further, such use of the shoulders will likely continue and even increase in response to the need for operational flexibility during maintenance and reconstruction; during accident clean-up; during rush hour; during lane closure for any one of a number of reasons like flooding, truck load spillage, restriping, sign erection, stalled vehicle(s), research instrumentation, installation of energy attenuating devices, removing backslope slide debris, keeping traffic out of dangerous fill settlement areas or slide depressions, etc.

The one big question not answered here is: "Why do we continue to pretend to face the dual realities of important shoulder uses and high maintenance costs and yet continue to build new shoulders to such low standards that we perpetuate high maintenance costs?" We should, of course, also address ourselves to the question of what to do about improving a substandard system with shoulders constructed thirty or forty years ago. But we must not so confuse these two separate questions that we continue to build substandard shoulders in spite of knowing how to do better. One cannot help but agree with Neilon J. Rowan's statement that technology in shoulders is ahead of research. However, it should also be noted that technology appears to be considerably ahead of implementation. This being the case, insufficient attention has been devoted to the design and construction of shoulders on new Interstate highways and urban expressways so as to avoid known past mistakes for which we are still seeking stop-gap maintenance solutions at a greater annual cost than original construction of full depth monolithic pavements throughout the entire width of the shoulder. Constructing shoulders of the same pavement as the through traffic lanes has been noted to create enforcement and operational problems.

It should also be noted that nowhere in the discussion of "enforcement problems" related to unauthorized shoulder uses was there mention of any accident costs or the cost of any reduced capacities resulting directly from unauthorized shoulder uses. This is indeed an interesting omission.