

# Misunderstood Applications of Urban Work Zone Traffic Control

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Traffic control manuals do not sufficiently address many of the problems associated with urban arterial work zones. The traffic control devices applied within these work zones are sometimes misunderstood by the motorist. In order for there to be safe operations within urban roadway work zones, it is important that the traffic control be applicable to this specific environment. A motorist survey was initiated on Abrams Road in Dallas, Texas, to investigate comprehension of construction traffic control devices. Abrams Road is a four-lane undivided major urban arterial roadway. The survey was designed to meet the following objectives: (a) to ascertain knowledge about work zone traffic control, (b) to determine problematic construction traffic control devices with respect to motorist comprehension, (c) to elicit information from motorists concerning overall problems with the Abrams Road project, and (d) to substantiate or negate findings from a similar study in Houston, Texas. Personal interviews were conducted with 345 respondents in the Abrams Road area. These participants were asked to respond to questions regarding work zone signing and other forms of traffic control devices. The response percentages substantiated most of the findings from the earlier study revealing that motorists have some difficulty comprehending selected work zone traffic control applications.

Arterial street systems are being forced to sustain a significant portion of the traffic burden caused by increased congestion on freeways. The Texas State Department of Highways and Public Transportation (SDHPT) implemented a \$100 million program [Principal Arterial Street System (PASS)] in September 1987 to upgrade urban arterials. This program was intended to provide additional capacity and improve traffic flow. The initiation and implementation of the PASS program has led to the recognition of shortcomings in the construction traffic management of urban arterials.

Construction traffic control on arterials in highly developed urban areas faces many problems that are not currently addressed in the *Manual on Uniform Traffic Devices for Streets and Highways* (1). These problems include increased driver workload associated with limited right-of-way, variable speeds and volumes, excessive turning movements, extensive driveway access points, and construction signing requirements.

There is a lack of documented research relating to urban arterial construction traffic control. In addition to this, there is a large discrepancy between applicable signing for freeway and highway work zones and that recommended for urban arterial work zones (2,3). Motorists appear to be confused by selected traffic controls that are applied within urban arterial construction (4). The Texas Transportation Institute (TTI) has documented motorist general confusion in understanding roadway construction signing (5,6).

Several problematic work zone traffic control applications were identified in an earlier survey by TTI (7) that was performed in Houston, Texas. The results indicated that motorists had problems understanding certain word and message symbols applied in roadway construction work zones. The objective of this study was to substantiate or negate similar findings from the previous study in Houston (7).

## INTRODUCTION

Abrams Road is a four-lane undivided major arterial located on the north side of Dallas, Texas (Figure 1). Reconstruction began in July 1989. This 2-mi segment of roadway extends from Forest Lane to Kingsley Boulevard. The reconstructed facility will feature a six-lane divided cross section. The traffic volume in January 1990 was approximately 20,000 vehicles per day (vpd) and included four signalized intersections. The primary land use along the arterial is residential with some retail businesses.

The traffic control plan initiated on the project, for the most part, exceeded the requirements of the *Texas Manual on Uniform Traffic Control Devices* (8). This survey was administered in May 1990 to investigate motorists' interpretations of construction traffic control devices and their perception of the urban arterial work zone.

## STUDY DESIGN AND METHODOLOGY

The Abrams Road survey was designed to meet the following objectives:

1. Ascertain knowledge about work zone traffic control,
2. Determine motorist comprehension of applied construction traffic control devices,
3. Elicit information from motorists concerning overall problems with the Abrams Road project, and
4. Confirm findings from a similar study conducted previously in Houston, Texas.

Surveys were conducted with 345 respondents in May 1990 at three locations. Respondents at all locations were approached by the surveyors and asked if they would like to participate voluntarily in the survey. A daily demographic total was kept to address any biases that might develop. The result was that 147 respondents were interviewed at a Texas Department of Public Safety licensing office and a total of 198 respondents were interviewed at two commercial locations.

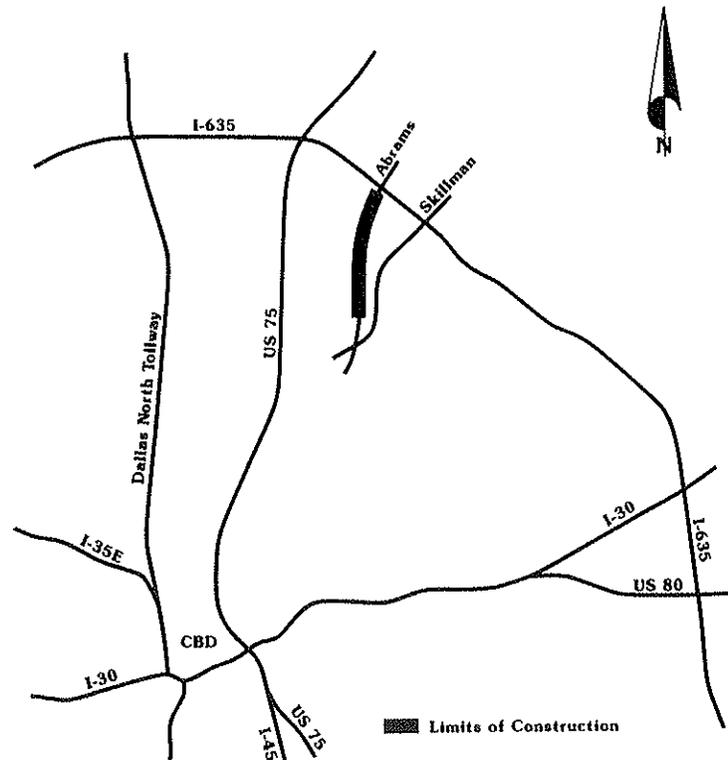


FIGURE 1 Route map of Dallas, Texas.

Survey participants were queried on their opinions about various aspects of the reconstruction project. This was followed by a brief set of biographical questions. The participants were then asked to respond to questions regarding work zone signs and other forms of traffic control devices that were presented photographically both in and out of context, as an independent element of the overall traffic control plan.

The Dallas survey results were compared with responses from the Houston survey, which was of a similar type. However, the sample size used in Houston was approximately half of that used in Dallas. It was intended that the surveys support one another as representing similar results from different geographical areas.

## RESULTS

Motorists were first asked about their opinions of the Abrams reconstruction. Figure 2 shows a listing of all the questions with their response frequencies.

"Hazardous road conditions" was the biggest problem as seen by the participants, followed by "The construction is taking too long." Subsequently, drivers were asked, "if they were utilizing alternate routes?" Approximately 65 percent responded that they were using alternative routes.

When asked, "if there are too many, too few, or the right amount of construction signs that give directions to places alongside the construction area?" the response given most often (54 percent) was that there are the right amount of directional signs for the construction area. However, 21 per-

cent said there were too few, 21 percent said they were not sure, and 4 percent said there were too many.

When asked the same question about the number of barrel drums used for channelization, the participants responded most often (50 percent) that there were the right amount. On the other hand, 23 percent said they were not sure, 16 percent said there were too many, and 11 percent said there were too few.

The drivers were also asked, "if they had any trouble getting to specific places because of the construction?" Over 68 percent of the drivers responded that they did not have any problems getting to their destinations. Finally, when asked, "Do the future benefits of this construction outweigh the present inconveniences?", approximately 84 percent responded "yes."

The second part of the survey asked the participants to respond to questions regarding work zone traffic control. This part of the survey revealed that drivers have some difficulty correctly interpreting messages on construction signs. A sample of the work zone control device questions is shown in Figure 3. The response percentages for each device are discussed in the following sections.

### Road Construction 500 ft

Over two-thirds (69 percent) of the participants correctly interpreted the sign in Figure 4. However, approximately 22 percent of the respondents interpreted the sign to mean that the next 500 ft of road are under construction. The Houston

1. Have you travelled on Abrams Road during the current construction?  
84% - Yes 16% - No
2. How often do you travel on Abrams?  
44% - One or more trips each day  
32% - One or more trips each week  
18% - One or more trips each month  
6% - Less than once a month
3. What is the biggest problem in the Abrams construction area?  
25% - Hazardous road conditions  
24% - The construction work is taking too long  
18% - Travel delay caused by construction  
8% - Too much traffic  
8% - Difficulty making turns due to congestion  
7% - Other  
5% - The construction zone is too long  
5% - Inadequate or confusing lane stripping
- 4a. During what time do you experience delay, if any, due to construction?  
34% - Evening rush hour  
26% - Morning rush hour  
26% - Other time period  
14% - No delay experienced
- 4b. How much time does the construction delay you?  
34% - Less than 5 minutes  
29% - 6-10 minutes  
19% - No delay experienced  
10% - 11-15 minutes  
8% - More than 15 minutes
5. Is this delay reasonable?  
52% - Yes 16% - No delay experienced  
21% - No 11% - Not Sure
- 6a. Are you using alternate routes?  
65% - Yes 35% - No
- 6b. If you are using alternate routes, what are they?  
39% - Greenville 26% - Skillman  
35% - Other
- 7a. Do the future benefits outweigh the present inconveniences?  
84% - Yes 5% - No  
11% - Not Sure
- 7b. If no or not sure, why?  
36% - Other  
28% - None Given  
16% - Construction work is taking too long  
12% - Fine before widening  
8% - Cost too high, bad construction planning
8. Do you have trouble getting to specific places because of the construction?  
68% - No 32% - Yes
9. How are the construction signs?  
54% - Right amount 21% - Not Sure  
21% - Too few 4% - Too many
10. How are the construction barrels?  
50% - Right amount 16% - Too many  
23% - Not Sure 11% - Too few
11. How would like to receive roadway project information?  
27% - Radio 12% - Newsletter, flier, etc  
26% - Newspaper 9% - Utility bill stuffer  
23% - Television 3% - Local cable channel
12. Which radio station(s) do you listen to for news?  
36% - Other 5% - KKDA-104.5 FM  
19% - None 5% - KSCS-96.3 FM  
17% - KRLD-1080 AM 5% - KERA-90.1 FM  
8% - KVIL-1150 AM, 103.7 FM  
5% - KLIF-190 AM
- 13a. Where do you currently get traffic/road closure information?  
54% - Radio 18% - Television  
19% - Newspaper 9% - Other
- 13b. Other traffic/road closure information?  
66% - No information received  
14% - Road Signs  
8% - Other  
6% - Call traffic information agency  
6% - Homeowners association
14. Do you have concerns about other highway projects in the Dallas area?  
39% - Other  
29% - None given  
24% - N. Central-Miscellaneous  
7% - Skillman-Miscellaneous  
6% - N. Central-Should have been done sooner  
5% - N. Central-Too much traffic, causes delays

FIGURE 2 Questionnaire response summary.

1. What does this sign tell you? (Figure 4)
  - A. There are 500 feet of construction 500 feet ahead
  - B. The next 500 feet of road are under construction
  - C. A construction area is located 500 feet ahead
  - D. Not sure
2. How would you respond to this sign? (Figure 5)
  - A. Turn left
  - B. Stop
  - C. Change lanes
  - D. Not sure
3. Why are these signs different colors? (Figure 6)
  - A. Yellow is for school zones, Orange is the standard color for warning signs
  - B. Yellow is the standard color for warning signs, Orange is for construction signs
  - C. There is no difference between the two
  - D. Not sure
4. What does this sign tell you? (Figure 7)
  - A. Low shoulder
  - B. Uneven pavement
  - C. Bumpy road
  - D. Not sure
5. What do the orange and black arrows tell you? (Figure 8)
  - A. Do not turn left between signs
  - B. Shows the direction of the roadway
  - C. Sharp turns in the road
  - D. Not sure
6. On which side of this sign would you drive? (Figure 9)
  - A. Drive to the right of these signs
  - B. Drive to the left of these signs
  - C. Drive to either side of these signs
  - D. Not sure
7. Where would you turn left? (Figure 10)
  - A. Before the Crossover sign
  - B. After the Crossover sign
  - C. Either before or after the Crossover sign
  - D. Not sure
8. What do the white posts on the right tell you? (Figure 11)
  - A. Shows the driveway locations along the roadway
  - B. Shows the right edge of the pavement
  - C. Park between these posts
  - D. Not sure
9. What does this sign tell you? (Figure 12)
  - A. Road construction ahead
  - B. Flagger ahead
  - C. Guard for school crossing ahead
  - D. Not sure
10. What does this sign tell you? (Figure 13)
  - A. Median narrows
  - B. Right lane ends
  - C. Right lane turn marker
  - D. Not sure
11. What does this sign tell you? (Figure 14)
  - A. Leave room for traffic crossing at intersection
  - B. If your car stalls, move it out of the intersection
  - C. Avoid driving through the intersection
  - D. Not sure

FIGURE 3 Sign questionnaire.



FIGURE 4 Advance road construction sign.

survey produced similar results, with only 66 percent correctly identifying the sign.

#### Right Lane Ends Sign

Ninety percent of the respondents correctly interpreted the sign in Figure 5 to indicate that a change in lanes was necessary. The correct response to the Houston survey was approximately 93 percent.

#### Color Cue Difference

In the past, distinguishing different color cues has not been accomplished well by the motorist. When drivers were shown the Two Way Traffic sign (see Figure 6), one yellow and one orange, and asked the meaning of the two different colors, only 50 percent knew that orange is the color designated for construction. Twenty five percent were not sure of the difference and the other 25 percent gave an incorrect interpretation. In Houston, only 44 percent knew the correct meaning of the two colors and 40 percent said they were not sure of the difference.



FIGURE 5 Right lane ends sign.

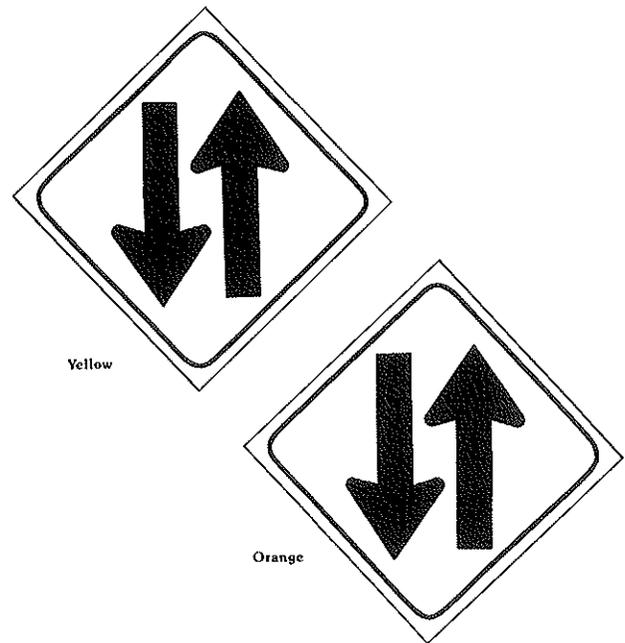


FIGURE 6 Color cue difference of signs.

#### Low Shoulder Symbol Sign

This sign (shown in Figure 7) was incorrectly interpreted by a majority of the respondents. Over three-quarters (76 percent) thought this sign meant uneven pavement. The Houston survey had a similar response of 84 percent.

#### Chevron Alignment Sign

Eighty five percent of the respondents correctly interpreted the sign in Figure 8 to indicate that the signs show the direction of the roadway. The correct response to the Houston survey was approximately 92 percent.



FIGURE 7 Low shoulder symbol sign.

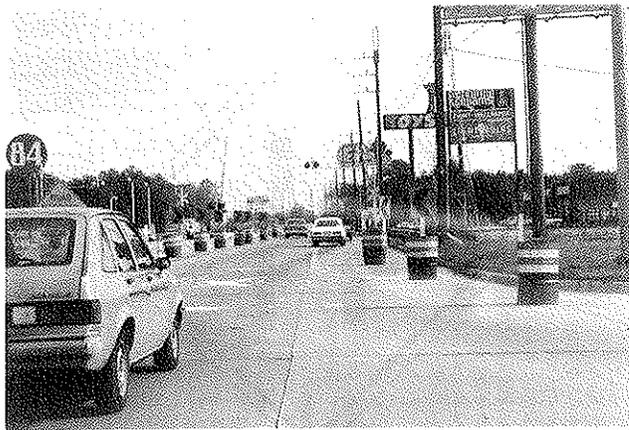


FIGURE 8 Chevron alignment sign.



FIGURE 10 Crossover sign.

**Vertical Panel**

Orange and white hazard markers were shown to the survey respondents (see Figure 9). Drivers were asked, "on which side of these signs they would drive?" Thirty eight percent responded incorrectly, whereas 46 percent were not sure. The Houston survey did not specifically address this sign. However, some indications of the previous survey exhibited incorrect interpretations of the sign.

**Crossover Sign**

These signs do not clearly convey where to cross over within the construction area (see Figure 10). Because of the limited spacing requirements of urban arterial construction zones, it is extremely difficult to provide sufficient spacing for crossover situations. There are no current signing alternatives available to delineate a crossover situation within a construction zone. Therefore, the standard green crossover sign was used. When drivers were asked where they would turn left, 53 percent said before the sign, 26 percent said after the sign,

and 13 percent were not sure. The Houston survey had similar results in that 55 percent responded that it was permissible to cross over before the sign, 42 percent indicated it was permissible to turn after the sign, and 3 percent were not sure.

**White Delineator Posts**

These delineators (Figure 11) were used in conjunction with white raised pavement markers within the construction area to delineate clearly the edge of pavement. Seventy five percent of the drivers interpreted these correctly, whereas 9 percent did not correctly interpret the markers, and 16 percent were not sure of their meaning. The Houston survey revealed that 58 percent interpreted the markers correctly, 36 percent misinterpreted them, and 6 percent of the respondents were not sure.

**Advance Flagger Symbol Sign**

The Flagger Ahead symbol, shown in Figure 12, was interpreted correctly by 79 percent of the respondents; 21 percent interpreted the symbol incorrectly. The Houston survey re-



FIGURE 9 Orange and white hazard marker (vertical panel).



FIGURE 11 White delineator posts.



FIGURE 12 Advance flagger symbol sign.

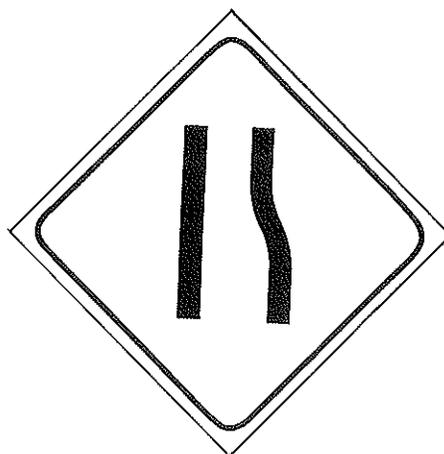


FIGURE 13 Lane reduction transition symbol sign.

vealed similar results with 78 percent correctly interpreting the symbol.

**Lane Reduction Transition Symbol Sign**

The Lane Reduction Transition symbol, shown in Figure 13, was interpreted correctly by 74 percent of the survey, whereas 20 percent misinterpreted the symbol and 6 percent were not sure. The Houston survey revealed that 78 percent interpreted the symbol correctly, 19 percent incorrectly interpreted the symbol, and 3 percent were not sure.

**Do Not Block Intersection Sign**

Eighty eight percent of the survey participants correctly interpreted the sign in Figure 14 to indicate that the driver must leave room for traffic crossing at the intersection. The Houston survey revealed that 74 percent of the respondents answered correctly.

A brief demographic summary concluded the interview. The results are presented in Table 1 along with the Dallas

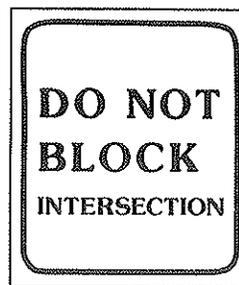


FIGURE 14 Do Not Block Intersection sign.

regional population statistics. The survey sample size was representative of the overall population.

**CONCLUSIONS**

The survey format of in- and out-of-context traffic control device photographs provided as identifying assessment of motorist confusion in understanding work zone arterials. How-

TABLE 1 DEMOGRAPHIC SUMMARY

Demographic Survey	Survey Sample	** Regional Population **
SEX: Male	48%	48%
Female	52%	52%
AGE: < 25	17%	20%
26 - 55	60%	56%
> 55	23%	24%
ETHNICITY: Anglo	72%	76%
Black	16%	15%
Hispanic	6%	8%
Other	6%	1%
EDUCATION: College Graduate	52%	---
Some College	31%	---
High School Graduate	13%	---
< High School	4%	---

\*\* Source: Bureau of Census (1988)

ever, the interpretations of the survey may not necessarily predict responses within the roadway environment when used as part of a complete traffic control plan. Specific problems identified in the development of the survey included presenting appropriate responses in an unbiased instrument that would serve the researcher's needs and being able to collect a representative sample of the population.

The survey did indicate that the motorists have problems understanding selected work zone signing. There was some confusion experienced by 31 percent of the respondents with the interpretation of the advanced construction sign. The difference between the standard color cues, yellow warning sign and orange construction sign, was incorrectly identified by 25 percent of the respondents, and 25 percent were not sure of the difference. The orange and white hazard markers (vertical panels) were also identified as a problematic sign by 84 percent. The behavioral response of the placement of the standard Crossover sign was interpreted incorrectly by 47 percent. Over three quarters (76 percent) responded incorrectly to the low shoulder symbol sign. The other survey results showed some indications of minor problems.

The Houston survey indicated similar misinterpretations of the advanced construction, difference of color cues, orange and white hazard markers (vertical panels), Crossover, and low shoulder signs. Further education of the motoring public or investigation of alternative signing schemes to improve comprehension was not within the scope of this study. However, further research of motorist understanding and appropriate response for ensuring safe negotiation of roadway work zones seems justified.

Motorist concerns on the Abrams Road project seem to be concentrated around the construction work taking too long and the hazardous road conditions, 24 and 25 percent, respectively. Alternate routes were being used by 65 percent of the respondents. Motorists indicated that there were a sufficient amount of signs and channelizing barrel drums on the project, 54 and 50 percent, respectively. The overall perception of 84 percent of the respondents was that the benefits of widening the roadway would be worth the inconveniences they are experiencing now.

## ACKNOWLEDGMENTS

This study conducted by the Texas Transportation Institute was sponsored by the Texas State Department of Highways and Public Transportation (SDHPT).

The successful completion of this study required the cooperation and assistance of numerous agencies and individuals. The authors would particularly like to thank Laura Moore of the SDHPT, District 18, and the Texas Department of Public Safety for their assistance in this undertaking.

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*Publication of this paper sponsored by Committee on Traffic Safety in Maintenance and Construction Operations.*