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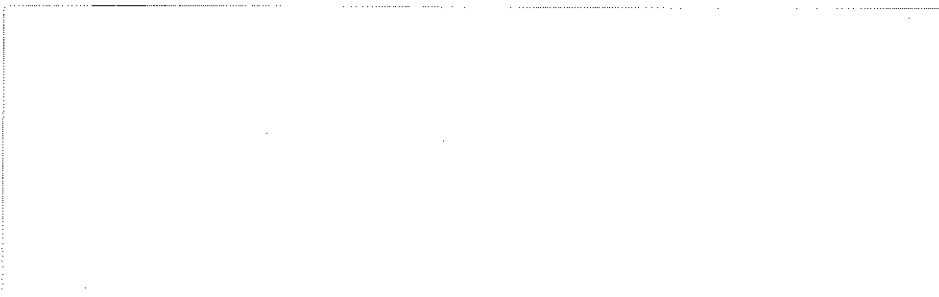
EVALUATION OF GLARE SCREEN



**TESTING AND RESEARCH DIVISION  
RESEARCH LABORATORY SECTION**



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**EVALUATION OF GLARE SCREEN**

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**Research Laboratory Section  
Testing and Research Division  
Research Project 73 F-135  
Research Report No. R-1249**

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Lansing, August 1984**

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## INTRODUCTION

Glare screen is placed between opposing streams of traffic to shield drivers' eyes from the headlights of oncoming cars. Traditional metal mesh type screens constructed of either steel or aluminum (Fig. 1) have proven to be quite expensive to install and subject to damage from plow-thrown snow, vehicle-induced wind-blast vibrations, and vehicle impact. The results have been poor appearance, impaired functioning, and considerable maintenance expense.

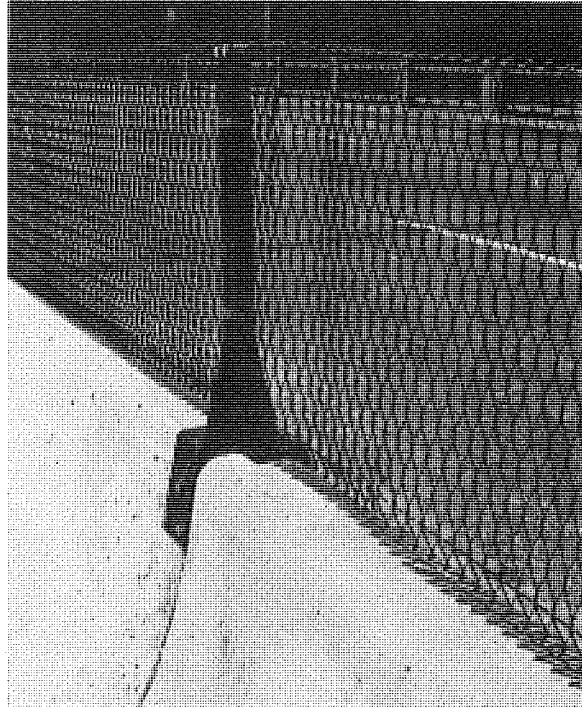


Figure 1. Traditional wire mesh glare screen.

As a means of alleviating the problems that had been encountered with mesh glare screen, Champagne-Webber Inc., a Michigan contractor, proposed in the spring of 1978, the concept of slip-forming a concrete glare screen on top of an existing concrete median barrier. Vertical tie-bars were used to secure the screen to the barrier and longitudinal reinforcement was added to reduce flying pieces of concrete in case of vehicle impact (Fig. 2).

The experimental concrete glare screen project consisted of two phases. Phase I consisted of constructing, curing, and destructively testing a short section of glare screen at the contractor's yard. A detailed description of Phase I follows and can also be found in Research Report R-879 (1). Champagne-Webber agreed to build a short experimental section of glare screen if the Department would pay for labor and materials. Phase II involved field evaluation of glare screen used on various construction projects, consisting of both concrete and metal mesh.

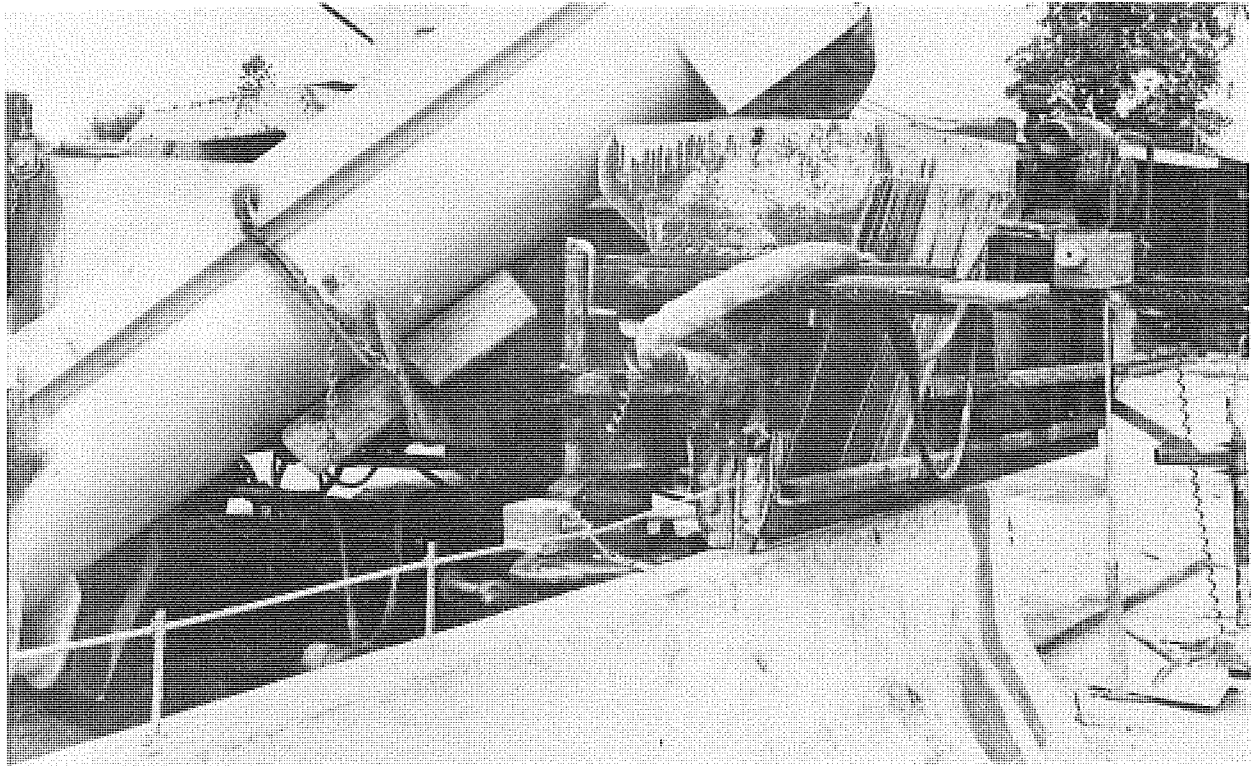


Figure 2. Slip-forming concrete glare screen on top of an existing median barrier. Note vertical tie-bars and longitudinal reinforcing steel.

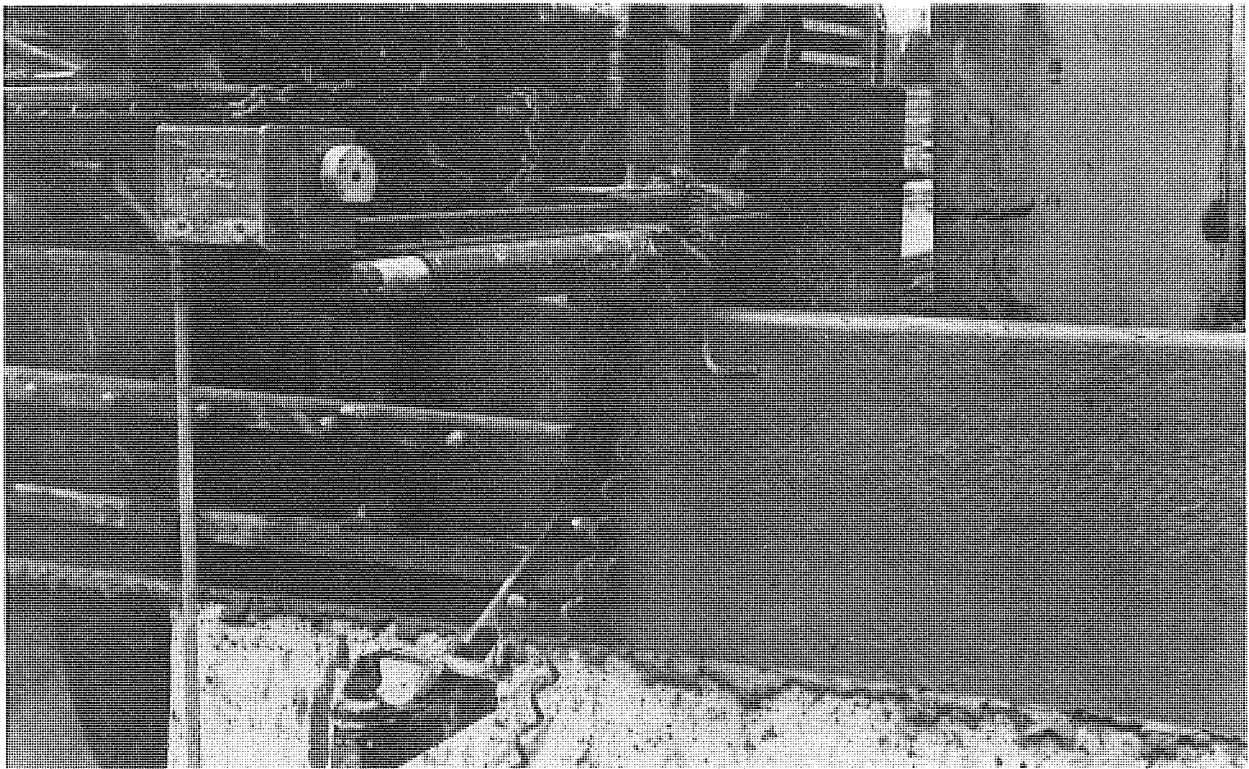


Figure 3. Concrete glare screen being constructed in the contractor's yard.

## PHASE I

### Construction

A section of experimental concrete glare screen, approximately 60 ft long, was cast at the contractor's yard. The concrete glare screen was slip-formed on an existing concrete median barrier as shown in Figure 3. Initially, there were some operational problems, but once the mix was properly adjusted to an approximate 2-in. slump, the glare screen was slip-formed quite readily. A portion of the glare screen contained no longitudinal steel so a comparative evaluation of screens with and without longitudinal reinforcement could be made. The mix used for the glare screen contained 17A aggregate and water reducer-retarder. High-early-strength concrete was used so destructive testing could be done sooner.

Originally two longitudinal rebars were included in the screen; however, during construction the upper longitudinal reinforcing bar tended to travel with the machine, causing tearing of the upper portion of the screen. Problems were also encountered with maintaining proper alignment of this bar due to the small cross-sectional area of the screen near the top. Because of these problems, the final test section contained only one longitudinal bar located approximately 8 in. above the existing barrier.

### Evaluation

The glare screen cured for two weeks before impact testing. Destructive evaluations were performed to determine the mode of failure; however, no precisely controllable device was available for striking the screen. Observations were subjective and the results are not expected to be accurately reproducible.

It was predicted that most traffic would probably strike the lower portion of the screen. It was decided to locate the point of impact near the top, however, subjecting the screen to its most severe impact condition. A wrecking ball, estimated to weigh 2,000 lb, was used to break the glare screen. It was swung by a crane and was not controllable to hit a precise location. The magnitude of impact was increased by swinging the ball through a greater arc. An additional test involved ramming a section of the screen with an end-loader. The result of this test, indicating the nature of the resulting fracture, is shown in Figure 4.

A summary of the findings is as follows:

1) Section with Longitudinal Reinforcement. Swing of approximately 10 ft, striking 6 in. from the bottom of the screen resulted in no damage. Swing of about 15 ft developed a vertical crack through the screen. After six 15-ft swings, one large piece was broken from the end with other large pieces of concrete flying no more than 3 to 4 ft. A hit near the top with a 25-ft swing knocked 6 to 8-in. pieces about 10 ft. The same impact



Figure 4. Glare screen being struck by a front-end loader.

at a lower point only caused a vertical crack. Figure 5 shows the type of failures which occurred in the concrete glare screen after being struck with the wrecking ball.

2) Section With No Longitudinal Reinforcement. A 20-ft swing approximately half-way down the screen caused only cracking. The third 20-ft swing fractured the screen off the wall in pieces approximately 2 ft in length. Figure 6 shows the types of failure encountered in concrete glare screen cast with and without the lower longitudinal rebar indicating the effectiveness of the rebar in holding larger fragments of concrete together.

### Conclusions

The limited evaluation of Phase I showed that slip-form construction of concrete glare screen on top of an existing concrete median barrier was feasible. Such an installation could be expected to provide long life, lower maintenance costs, and enhance safety. Based on the performance of the concrete glare screen under impact, the design details were modified to include only the bottom longitudinal rebar.

### PHASE II

Two glare screen sites were selected for the original evaluation. The first site was located on I 696 just west of Dequindre Rd containing all



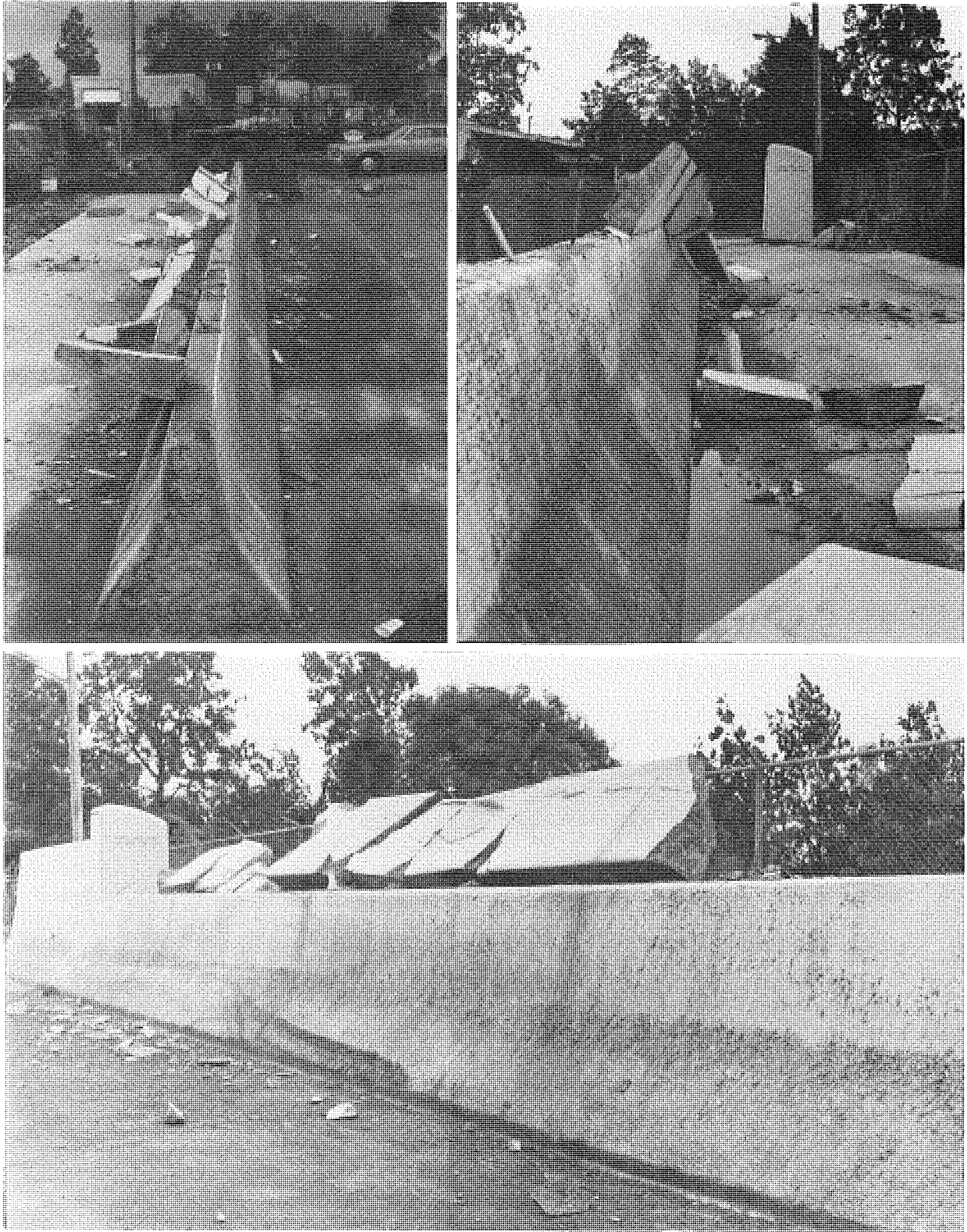


Figure 5. Damage to the glare screen after being struck by the wrecking ball.

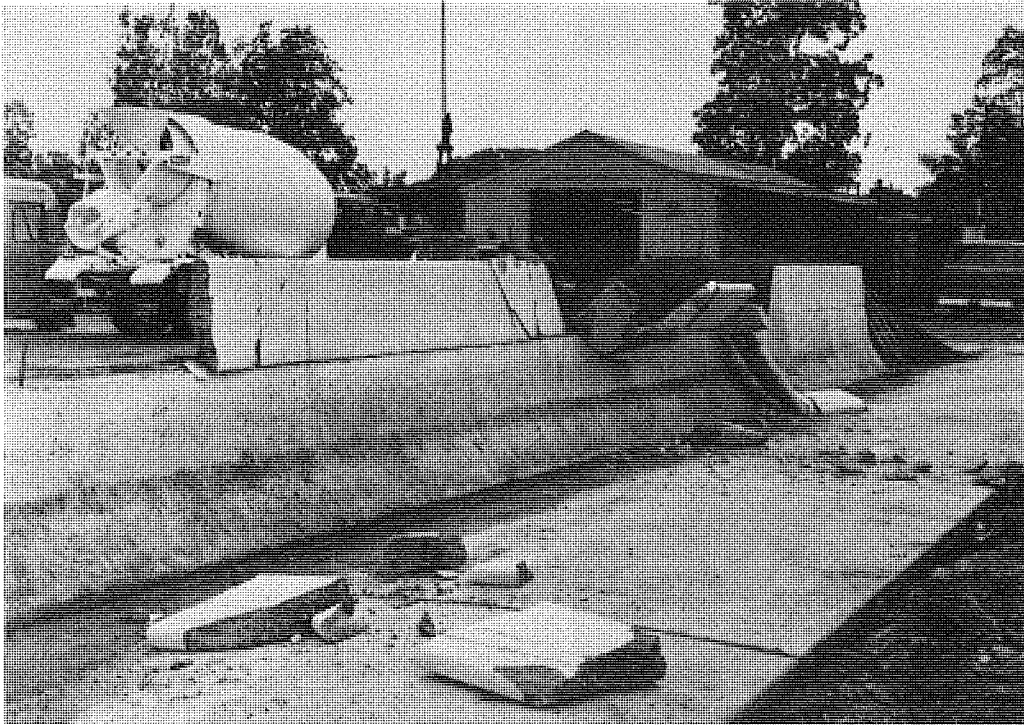


Figure 6. Damage to glare screen after impact with wrecking ball showing the difference between the portions with (right) and without (left) reinforcing steel.

concrete glare screen. A second installation of glare screen, located on Woodward Ave at Eight Mile Rd in Detroit, consisted of half steel mesh glare screen and half concrete. These sections were evaluated during construction in the summer of 1973 and again periodically until the final condition survey was conducted in the spring of 1983.

Concrete glare screen was also placed on an existing median barrier along I 94 near Jackson in the summer of 1977. This section was added to the project for comparative evaluation. Construction of this site was not observed and only a final condition survey in 1983 was conducted.

An additional installation along I 75 near Monroe was also evaluated. This location consisted of steel mesh and aluminum mesh sections, as well as concrete screen integrally cast with the median barrier. A final survey was conducted in the summer of 1983 and the results are presented for information, comparing the two types of metal mesh screens and the performance of integrally cast concrete glare screen and median barrier.

#### Construction

Approximately 1,150 ft of concrete glare screen containing vertical tie-bars and one longitudinal bar was constructed at the I 696 site during the summer of 1973. No unusual construction problems were encountered

and this section demonstrated the feasibility of constructing a concrete glare screen on an existing median barrier under actual field conditions. Only one side of this location had been opened to traffic during the evaluation period, and the westbound portion of I 696 still remains closed to traffic.

No unusual problems occurred on the Woodward Ave at Eight Mile Rd installation either. Approximately 2,050 ft of glare screen was constructed with vertical tie-bars and longitudinal reinforcement on the existing concrete median barrier. The other half of the installation consisted of steel mesh glare screen.

#### Evaluation of I 696 Location West of Dequindre Rd

The concrete glare screen, median barrier, and barrier base were evaluated in 1974, 1976, 1977, and 1983. The experimental section is located between Sta. 96+00 and 107+50. The final condition survey results are as follows:

1) Several vertical cracks were found in the concrete base, barrier walls, and glare screen. The amount of additional cracking that has taken place since the 1976 survey was significantly greater than that found at the Woodward Ave Location. Figure 7 shows some of the cracking found in the 1983 survey.

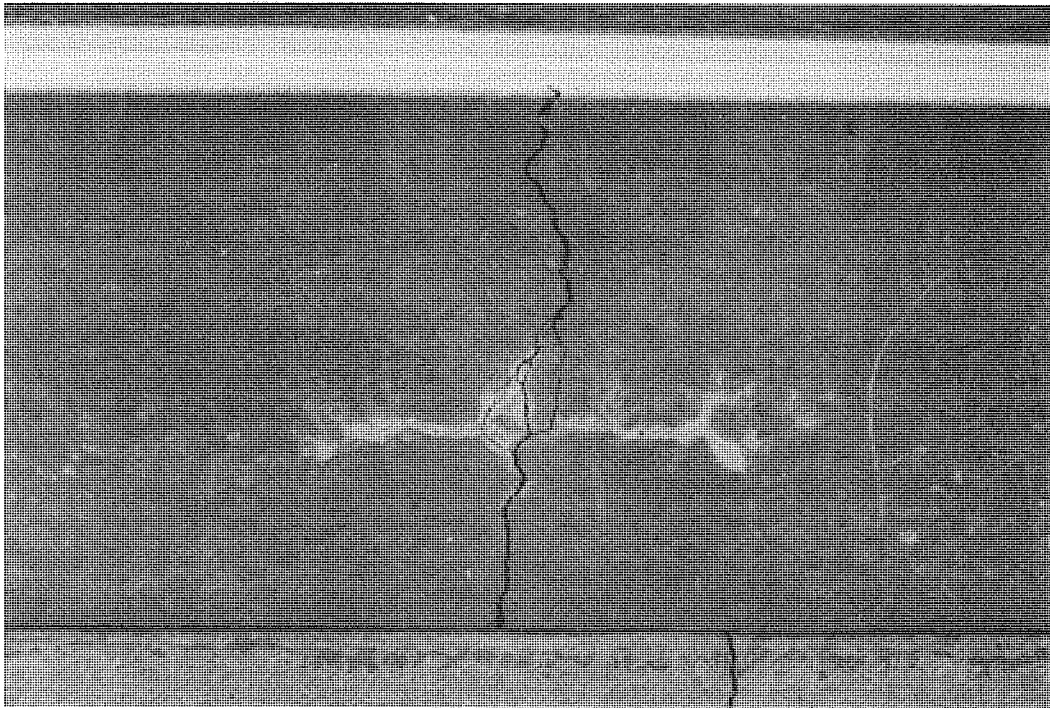


Figure 7. Cracking in concrete glare screen and median barrier, I 696, spring 1983.

2) A section of concrete glare screen in the vicinity of Sta. 102+75 appeared to have been hit. The glare screen was moved out of alignment, but did not separate from the barrier (Fig. 8).



Figure 8. Section of glare screen out of alignment on I 696, spring 1983.

3) A large number of vertical and longitudinal cracks are located near the light standard opening at Sta. 105+60 and the bridge near Sta. 107+00. None of these are affecting the performance of the glare screen at present.

The performance of this section of glare screen appears to be adequate, although the concrete is not performing as well as the concrete portion of the Eight Mile Rd Location.

#### Evaluation of Woodward Ave Location at Eight Mile Rd

The steel mesh and concrete glare screens along Woodward Ave at Eight Mile Rd were evaluated in 1974, 1976, 1977, and 1983. Since no maintenance appears to have been done to either the mesh or concrete screens during that time, the final condition survey describes the overall performance since construction.

1) All the original steel mesh glare screen which remains is in relatively good condition (Fig. 9).

2) The seven sections of steel mesh at the beginning of the project which were missing when the 1976 condition survey was conducted have not been replaced (Fig. 10). These apparently have not been hit by vehicles because the vertical supports are still in place. Figure 10 shows some evidence of buckling on the first post, but the rest do not seem to be damaged.

3) Six additional sections of the steel mesh glare screen have disappeared since the 1977 condition survey. These sections were located throughout the project and usually between two sections which remained intact.

4) Several fine surface cracks found during the original condition survey in the barrier wall and the concrete glare screen cannot be found. It is assumed that these cracks were first noted due to the curing compound emphasizing the cracks during the first survey.

5) Several expansion joints in the concrete glare screen contained no fiberboard filler, although the filler was still in the barrier wall below. The loss of this filler does not appear to be causing any problems with the performance of the glare screen.

6) Spalling of the concrete glare screen occurred near the contraction joints where the longitudinal rebar was not terminated but carried through the joint, thus exposing the steel. This appeared to be a problem at most of the contraction joints, but particularly those where the longitudinal reinforcing steel was spliced at or near the contraction joint (Fig. 11).

The overall performance of the concrete portion of this section is satisfactory. The steel mesh glare screen which remains is performing adequately. If the mesh screen were properly maintained, its functional performance would be satisfactory, although the concrete glare screen's overall performance would still be superior to the steel mesh, since none of the concrete has been destroyed.

#### Evaluation of I 94 Near Jackson

A condition survey was conducted in 1983 of the concrete glare screen placed on the median barrier near Jackson on I 94 between the Airport Rd and Elm Rd interchanges. The stationing is from approximately 774+65 to 948+00.

A summary of the findings follows:

1) Very little cracking was found between Sta. 744+65 and 783+90. Between these stations the expansion joints in the glare screen and the median barrier are spaced every 75 ft with two contraction joints spaced 25 ft apart between the expansion joints.



Figure 9. Steel mesh glare screen on Woodward Ave at Eight Mile Rd, spring 1983.

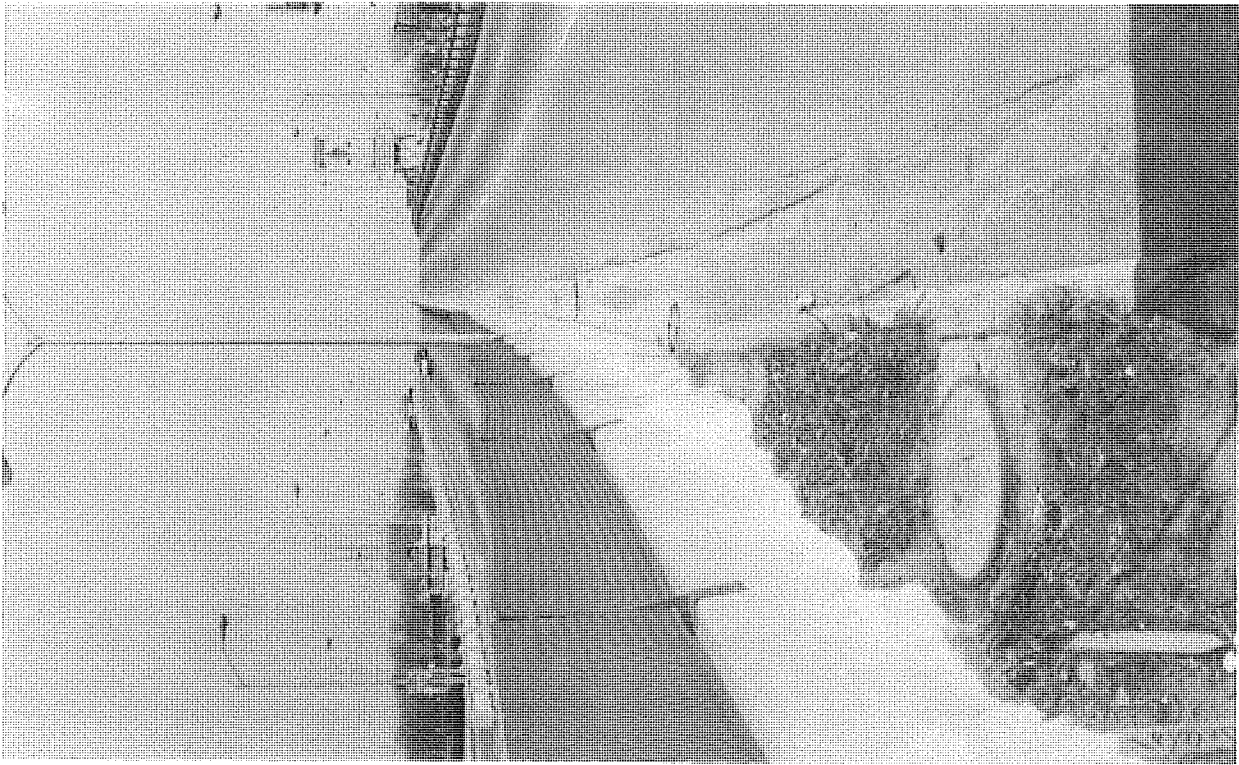


Figure 10. Missing section of steel mesh glare screen on Woodward at Eight Mile Rd, spring 1983.

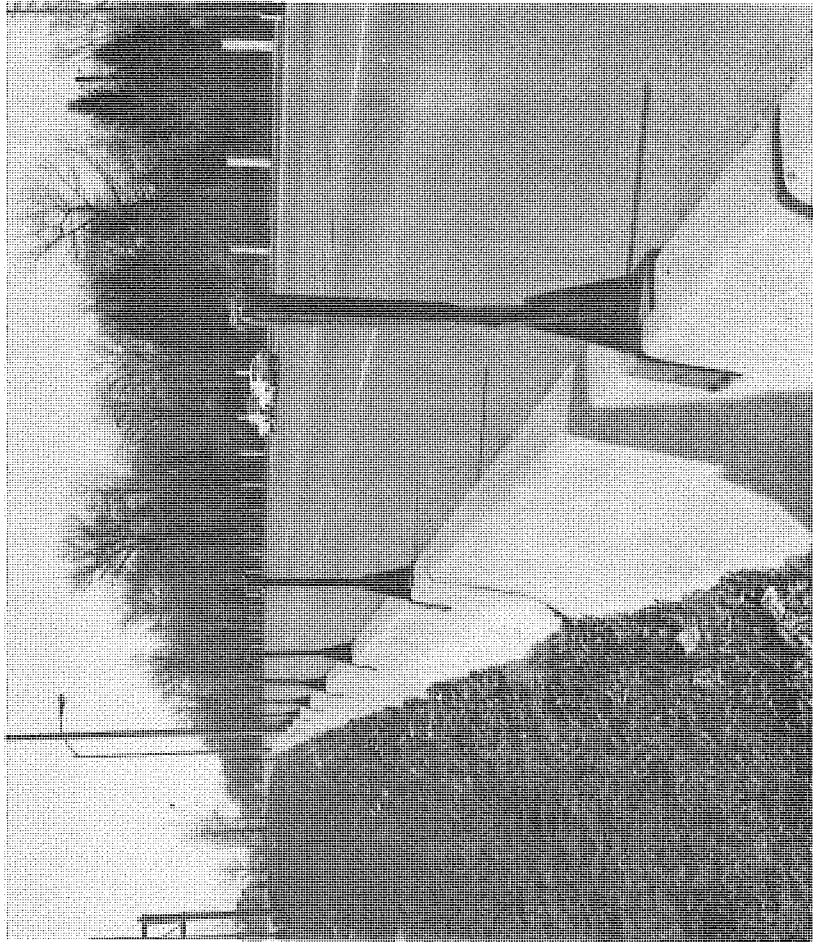
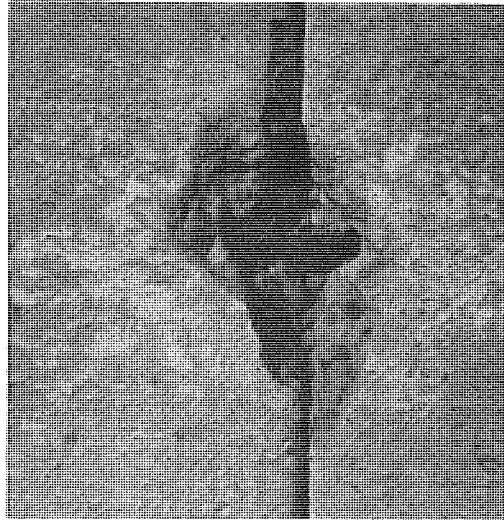


Figure 11. Spalling of glare screen where longitudinal steel was carried through a contraction joint on Woodward Ave at Eight Mile Rd, spring 1983.



2) There is considerably more cracking in both the glare screen and the median barrier from Sta. 783+90 to 948+00. A note added to the Standard Plans in 1975 states that contraction joints are to be put in the concrete glare screen to match cracks in the existing concrete barrier which appear to be functioning as joints. Several of these contraction joints were found in the concrete glare screen over existing cracks in the median barrier; however, many of these existing cracks did not appear to be acting as joints (Fig. 12).

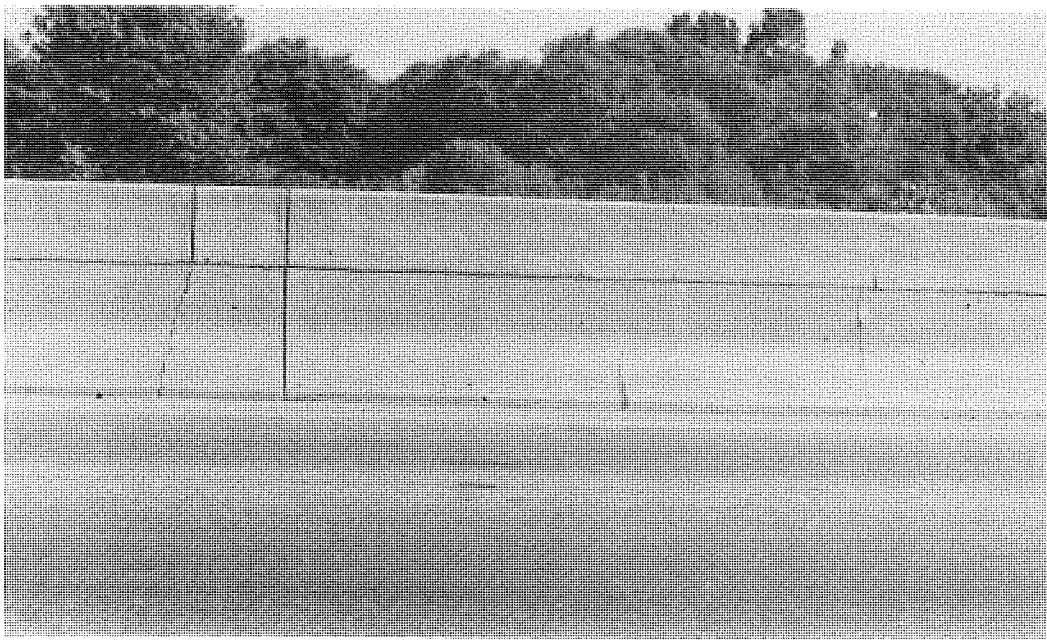


Figure 12. Cracking in concrete median barrier below contraction joints on I 94 near Jackson, summer 1983.

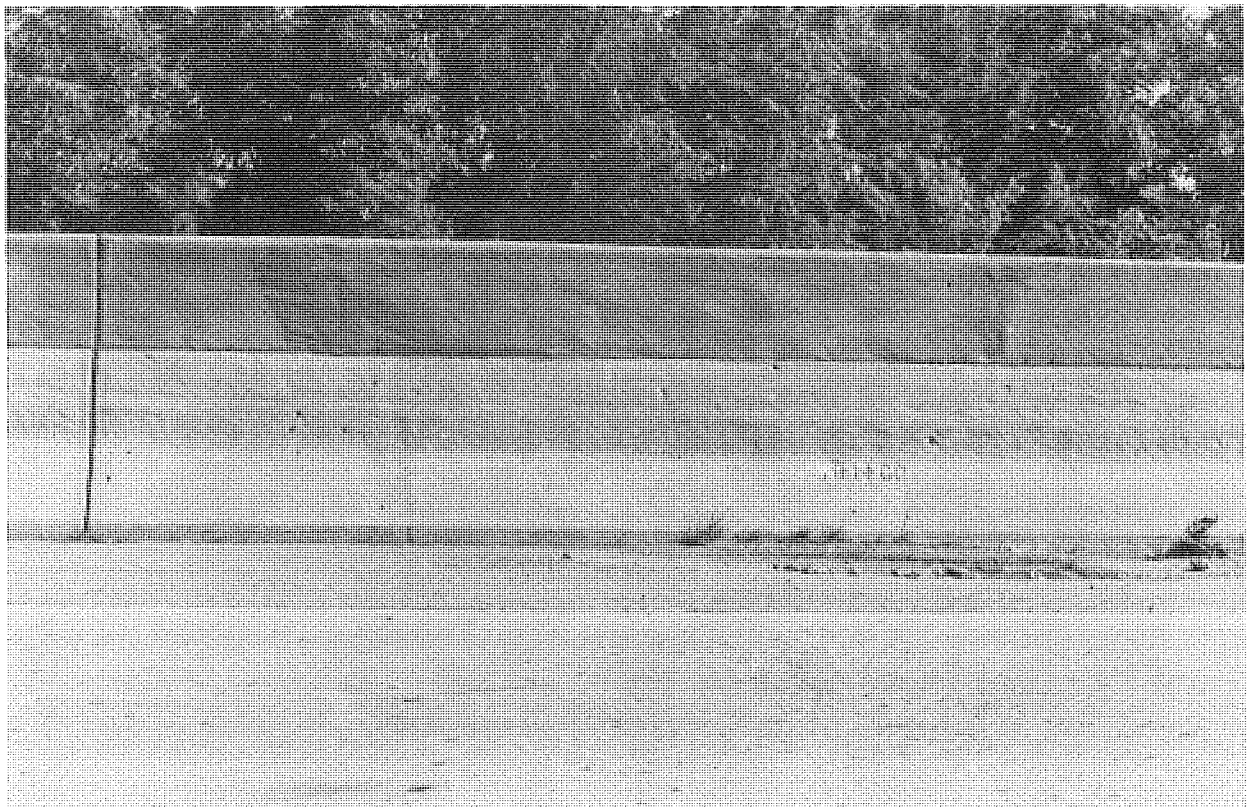
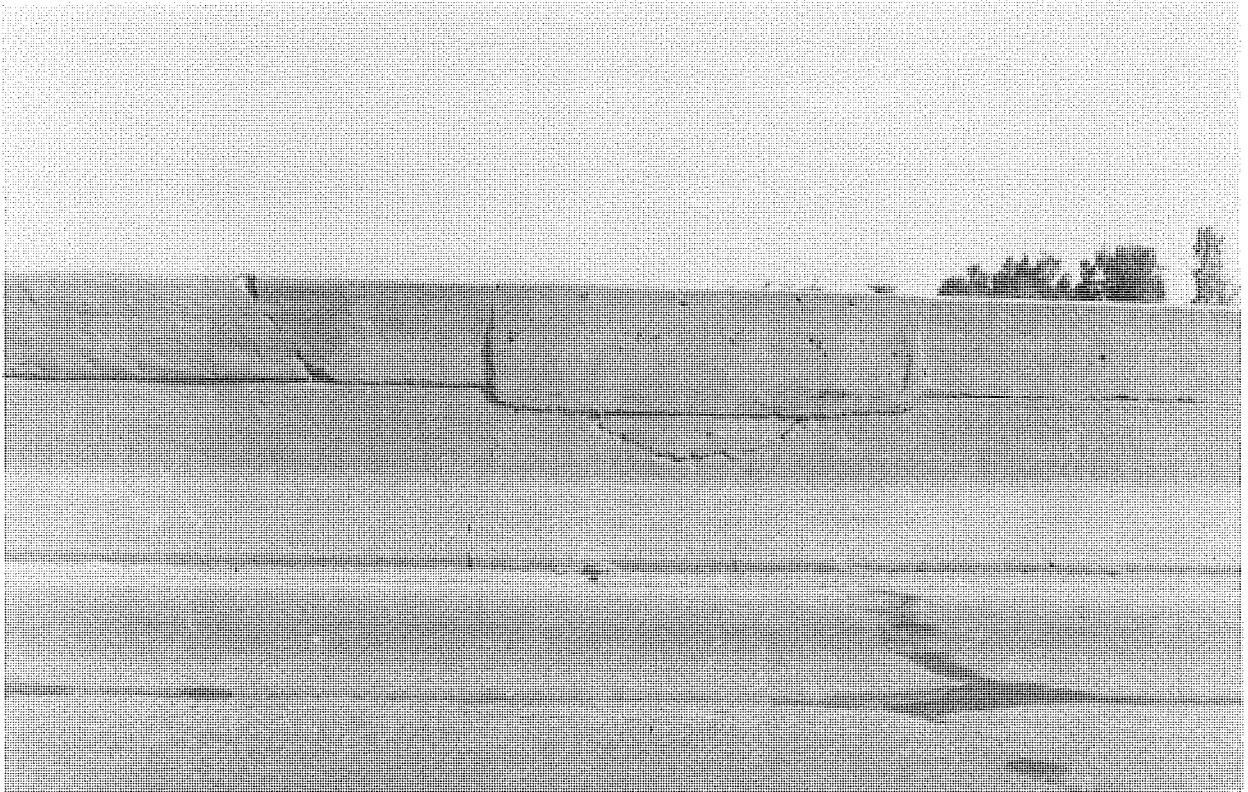


Figure 13. Repairs of concrete glare screen on I 94 near Jackson, summer 1983.



3) Several glare screen repairs were located throughout the section (Fig. 13). According to District 8 Maintenance personnel, these repairs averaged just under \$1,000 per repair during the 1983-84 fiscal year.

4) Many of the expansion joint fillers are missing (Fig. 14). As with the glare screens evaluated at previously described locations, this is not causing any performance problems.

5) Considerable spalling, with reinforcing steel exposed, was found approximately one mile west of Elm Rd (Fig. 15).

6) A section of glare screen near Elm Rd is missing, but there is no visible evidence of it having been hit by a vehicle (Fig. 16).

As with previous sections of concrete glare screen evaluated, the concrete glare screen is functioning as intended and is performing satisfactorily. Since this was the only section in which repair data were available, there is no way to determine the relative repair costs of concrete glare screen and metal mesh. However, much of the cost of any such repair is for the vehicles and personnel required for traffic control.

#### Evaluation of I 75 Location Near Monroe

The concrete glare screen is located between milepost 13 and 14. It was supposed to be a steel mesh glare screen but instead a concrete glare screen cast integrally with the concrete median barrier was found. The condition of this concrete glare screen and median barrier is as follows:

1) Curing compound remains on the concrete median barrier and glare screen, indicating this section to be relatively new.

2) Very little cracking was found in either the median barrier or the glare screen.

Steel mesh glare screen is located between Sta. 722+00 and 778+20, and the following observations made:

1) Of the original 899 mesh panels, 21 (2.3 percent) are missing.

2) Twelve (1.3 percent) of the remaining panels are severely damaged.

A combination of steel mesh and aluminum mesh glare screen is located between Sta. 1271+00 and 1364+00 and the results are as follows:

1) Of the 651 original panels of steel mesh glare screen, none were missing and 11 (1.7 percent) were damaged.

2) Eight (1.2 percent) of the panels in the "steel mesh" section were aluminum; probably replacements.

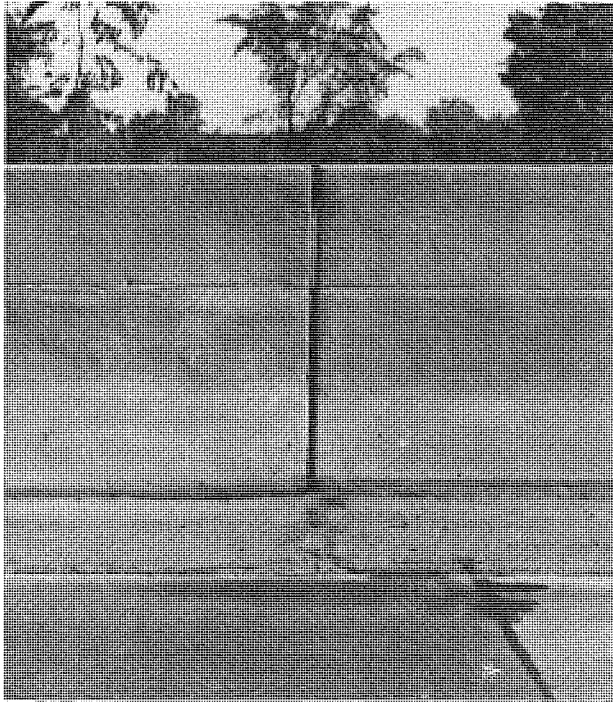


Figure 14. Missing expansion joint filler in glare screen on I 94 near Jackson, summer 1983.

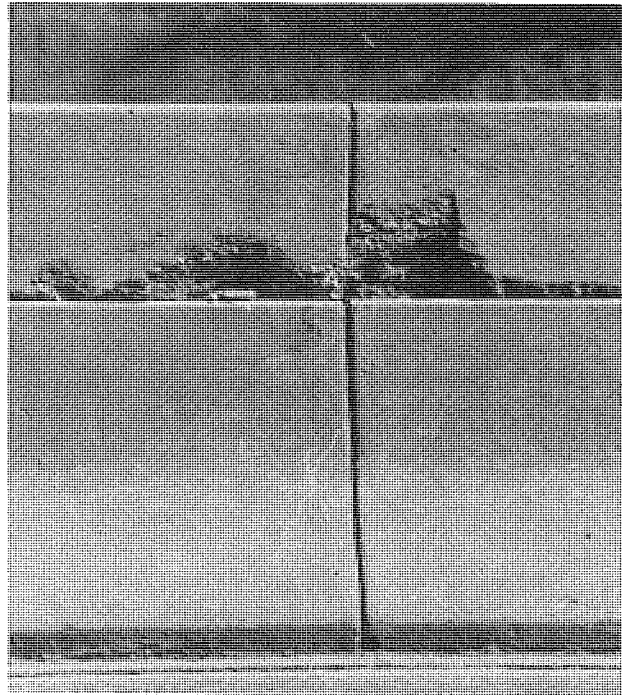


Figure 15. Spalling of glare screen on I 94 near Jackson, summer 1983.

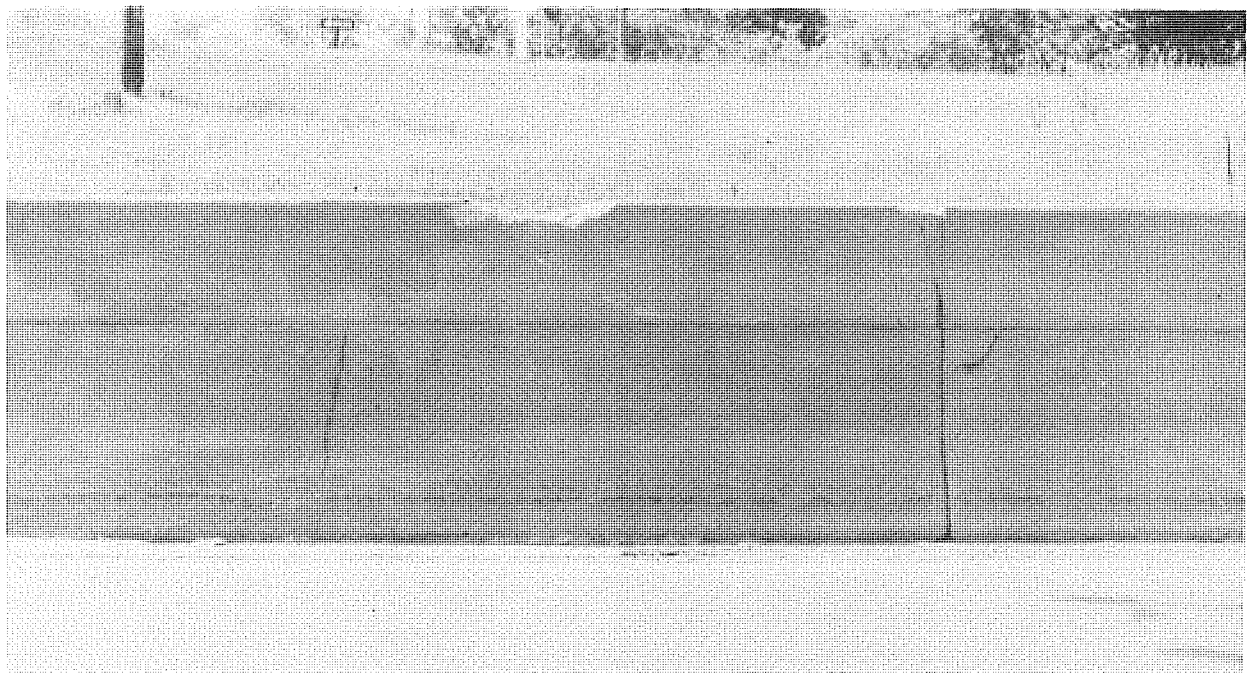


Figure 16. Piece of glare screen broken out, with no additional evidence of vehicular impact on I 94 near Jackson, summer 1983.

3) Of the original 837 panels of aluminum mesh glare screen, 317 (37.9 percent) were missing and 51 (6.1 percent) were damaged.

Evaluation of the steel and aluminum mesh glare screen sections indicate that the steel mesh performs better than the aluminum mesh; however the age of each section is not known and the steel mesh may be somewhat newer. The integrally cast concrete glare screen at this location is too new to make any long-term comparisons with that which is cast on top of an existing median barrier. The integrally cast, in theory, should be superior from the standpoint of strength and continuity.

## CONCLUSIONS

Concrete glare screen placed on top of an existing median barrier has generally given satisfactory results. The concrete screen appears to provide longer life than the conventional metal mesh type screen. The additional height provided by the concrete glare screen should provide the barriers with considerable strength, and may provide an extra measure of safety by preventing most cars that strike the barrier from riding on top of it.

It should be noted, however, that a statement was made in NCHRP Report No. 66 that, "Crash testing is needed to determine whether the additional height interferes with the effectiveness of the concrete barrier in redirecting vehicles." (2) This report was published in December 1979 and to date the 51-in. high combination Michigan median barrier and glare screen section has not been crash tested.

The steel mesh appeared to perform much better in the field than the aluminum mesh glare screen. Other investigations by the Department proved that the aluminum expanded mesh type glare screen failed within a relatively short period of time. It was found that many installations consisting of aluminum mesh were "over-expanded" so that there was little material left in the bridge area where the strands join together. Consequently, a small amount of vibration would cause the aluminum to fail. Because of this finding, the minimum thickness of metal mesh glare screen was increased from 0.051 in. to 0.081 in. The thicker aluminum and steel mesh sections appeared to have longer performance life but it was still found that the steel expanded mesh was less susceptible to fatigue type failures (3, 4).

Although it has not been in service long enough to be exposed to the conditions of the other types of glare screens, the concrete glare screen monolithically cast with the median barrier appears to be the most advantageous to use. Since there is no joint between the glare screen and the median barrier, the deterioration that normally occurs where the concrete glare screen is placed on an existing median barrier should be eliminated. This design should also be more economical because it is placed in a single operation with the barrier and according to Michigan Standard Plan III-76E,

no steel reinforcement is required when concrete glare screen is cast monolithically with the concrete barrier (5). Also, it is significantly stronger than the separately-placed screen, and will be subject to considerably less damage.

## RECOMMENDATIONS

If glare screen is desired where concrete barriers exist, it is recommended that the Department use concrete glare screen rather than steel mesh glare screen. Field evaluations have shown that most deterioration problems occur when the longitudinal steel used in the glare screen is carried through the joints or begins to rust and expand causing spalling and staining. The use of epoxy coated steel in the glare screen should be considered as a means of preventing the type of deterioration caused by rebar corrosion. This will protect the reinforcing steel from corrosion and delay spalling of the concrete. Another alternative to remedy the problem of deterioration near the longitudinal reinforcing steel would be to delete the longitudinal bar option from Standard Plan III-76E and use the inverted u-shaped bar detail only. In any case reinforcing steel should not extend through the expansion or contraction joints, as shown in Standard Plan III-76E.

In situations where a glare screen is desired to be placed on a median guardrail section (Type BD or CD in the Michigan Standard Plans) a metal mesh glare screen will have to be used. In this case, the steel mesh should be used in lieu of the presently available types of aluminum mesh because of its proven superior performance.

Ideally, concrete glare screen cast monolithically with the median barrier should be used whenever possible. Glare screen integrally cast with the barrier should be required where new installations include the use of glare screen and median barriers.

## SUMMARY

Concrete glare screen has proven to be feasible and should continue to be used in Michigan. Michigan Standard Plan III-76E should continue to be used, with a revision made that all reinforcement be epoxy coated in the concrete glare screen. If it is necessary to use a metal glare screen, the expanded steel mesh should be used, unless it is demonstrated that aluminum mesh has been developed that is as resistant to flexure as is the steel.

## REFERENCES

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