

INVESTIGATION OF PAVEMENT DAMAGE  
BY GASOLINE TRUCK FIRES TO M 20, (Control Section 56023)  
CITY OF MIDLAND AND US 27 (Control Section 37013, C4)  
SOUTH OF MT. PLEASANT

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Testing and Research Division  
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INVESTIGATION OF PAVEMENT DAMAGE  
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On October 25, 1969 two gasoline tanker trucks burned on State highways--in two separate accidents--within 15 minutes of each other. The first fire occurred on the northbound roadway of US 27 south of Mt. Pleasant when the driver tried to back onto the highway after taking a wrong exit. The second fire occurred in the city of Midland on E. Patrick St (M 20) following a collision at the Washington St intersection.

R. J. Gleason, District 6 Maintenance Engineer, requested the assistance of the Testing and Research Division through a telephone call and subsequent letter (Oct. 30, 1969) to J. C. Brehler. Testing and Research personnel arrived in Midland on October 29 and met Mr. Gleason at the fire-damaged roadway. Following the Midland inspection, the damaged pavement at Mt. Pleasant was inspected, although no assistance was requested from District 5 personnel.

Damage to the Concrete Pavement

Figure 1 shows a diagram of the damaged pavement in Midland. The center and south lanes were heavily spalled from Sta. 109+75 to 112+75. Spalled areas of less severity extended approximately 40 ft further at either end. The north lane was damaged to a much lesser extent. Cores were taken at various positions in the affected area to help determine the depth of the damage. Figures 2 and 3 show the condition of the damaged area. After our inspection, Mr. Gleason arranged for a temporary bituminous wearing surface to be placed over the damaged pavement.

Figures 4 and 5 show a diagram and photographs of the damaged pavement on northbound US 27 south of Mt. Pleasant. The most heavily damaged portion on the superelevated horizontal curve was confined to 95 ft between Sta. 493+63 and 494+58. This area had already been temporarily repaired with a bituminous cap, presumably by District 5 maintenance personnel. The shoulder area and the guardrail, both of which had been badly damaged, had also been repaired. The sod was burned-off the entire height of the embankment.

## Laboratory Investigation

Representative cores from the M 20 pavement were sliced vertically with a diamond saw to show a cross section of the damaged concrete. These slices were examined under a microscope at X40 magnification, and the following observations were made:

1. Differential thermal expansion, caused by the intense and sudden heat, had produced horizontal fracture planes from 1/8 to 1/4 in. below the concrete surface in the mortar areas. The same fracture planes in the large pieces of 4A aggregate were evident up to 3/4 in. deep. This variation in fracture depth occurred because the aggregate was a better conductor of heat than the air-entrained mortar.

2. The mortar at the top of the core, from 1/4 to 1/2 in. deep, had changed in color from a light gray to a pinkish-yellow. A study of available literature and consultation with our chemists revealed this to be cement from which the water of hydration had been driven by the heat. Hydrated portland cement attains its maximum expansion at 300 F; begins shrinkage at higher temperatures, and loses its water of hydration at 450 F. The shrinkage occurring in concrete exposed to these high temperatures over a significant length of time can ultimately equal or exceed a 0.5 percent decrease from its original dimensions and severe cracking results.

3. Craze or shrinkage cracks, whose formation was described above, were noted on the concrete surface of the Midland (M 20) cores, and on the area just north of the bituminous patch at the US 27 site (Fig. 5). The discolored portion of the core cross section slices from 1/4 to 1/2 in. below the top surface showed mortar separation cracks around the aggregate particles. These cracks will make the concrete very vulnerable to rapid freeze-thaw deterioration.

## Recommendations for Repair

A recent study of hydraulic patching mortars in the Research Laboratory<sup>1</sup> has confirmed that latex-modified mortars develop superior bonding strength to existing concrete substrates. Although definite field confirmation is still lacking, several patches have been placed within the last two years and are reported to be functioning well.

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<sup>1</sup> Patterson, H. L., "Evaluation of Five Commercial Fast-Setting Hydraulic Patching Mortars," Research Report No. R-715. October 1969.

With this latex-modified mortar available, a surface repair of the fire-damaged areas can be performed without full-depth replacement of the pavement. Mr. Gleason suggested, however, that the badly spalled curb and gutter in Midland be replaced over the full length of the damaged area.

Our recommendations for repairing the pavement next spring would essentially follow the procedures outlined in the MDSH supplemental Specifications for Latex-Modified Mortar or Concrete for Bridge Deck Repair (3-28-69), and would initially employ a grader-mounted scarifier for removal of the temporary bituminous wearing surfaces. The deteriorated concrete would then be removed with a specialized scarifying machine built by the G. H. Tennant Co. of Minneapolis. The manufacturer claims that the machine will rout a 12-in. path 1/4 to 3/8 in. deep in a single pass and will cover 200 to 350 sq yd per hour.

The severely spalled concrete should be removed to 1 in. below its present level and the light to moderately scaled concrete should be cut to 1/2 in. depth. This would expose a sound concrete surface to which the latex-modified mortar could be bonded. The perimeter of the scarified area should be sawed to a neat vertical edge, thus eliminating the necessity of feathering out the mortar. The cleaning and priming of the substrate and the placement and curing of the mortar should be done in accordance with the supplemental specification.

The Dow Chemical Co. has purchased a truck-mounted continuous batching and mixing machine which is available for leasing. The machine is ideal for this type of repair because it moves immediately ahead of the vibratory screed and dispenses the required amount of mortar.

At expansion joints, the damaged joint filler material should be removed to whatever depth necessary and replaced to within 1-1/2 in. of grade elevation. The remaining depth would be taken up by a wooden strip, temporarily nailed to the joint material, which could be removed after the mortar had set and replaced with hot-poured rubber-asphalt joint seal material.

At the Midland (M 20) site it is estimated that 600 ft of curb and gutter must be replaced and 40 cu yd of mortar must be used to repair the pavement. At the US 27 site, near Mt. Pleasant, it is estimated that 15 cu yd will be required to repair the pavement.

At both sites it would be preferable if traffic could be diverted to alternate routes while the repairs are being made.

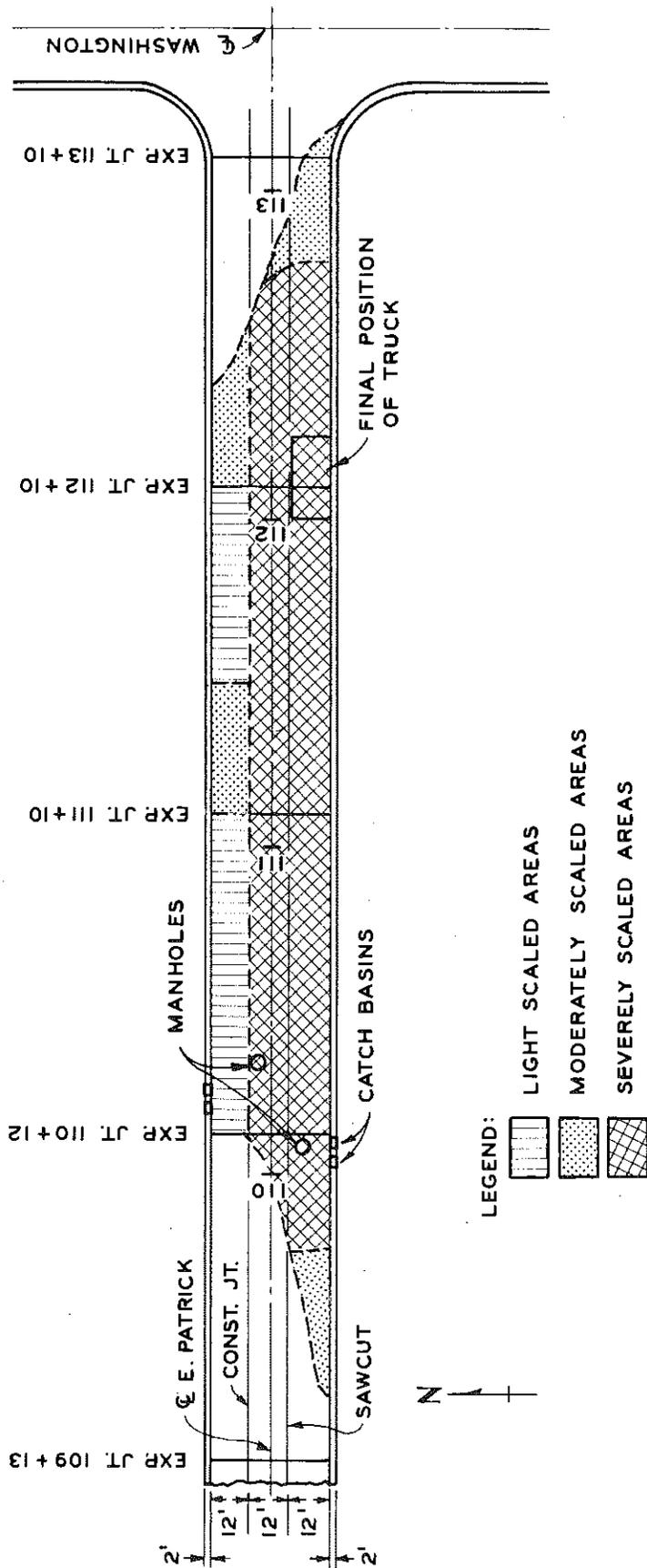
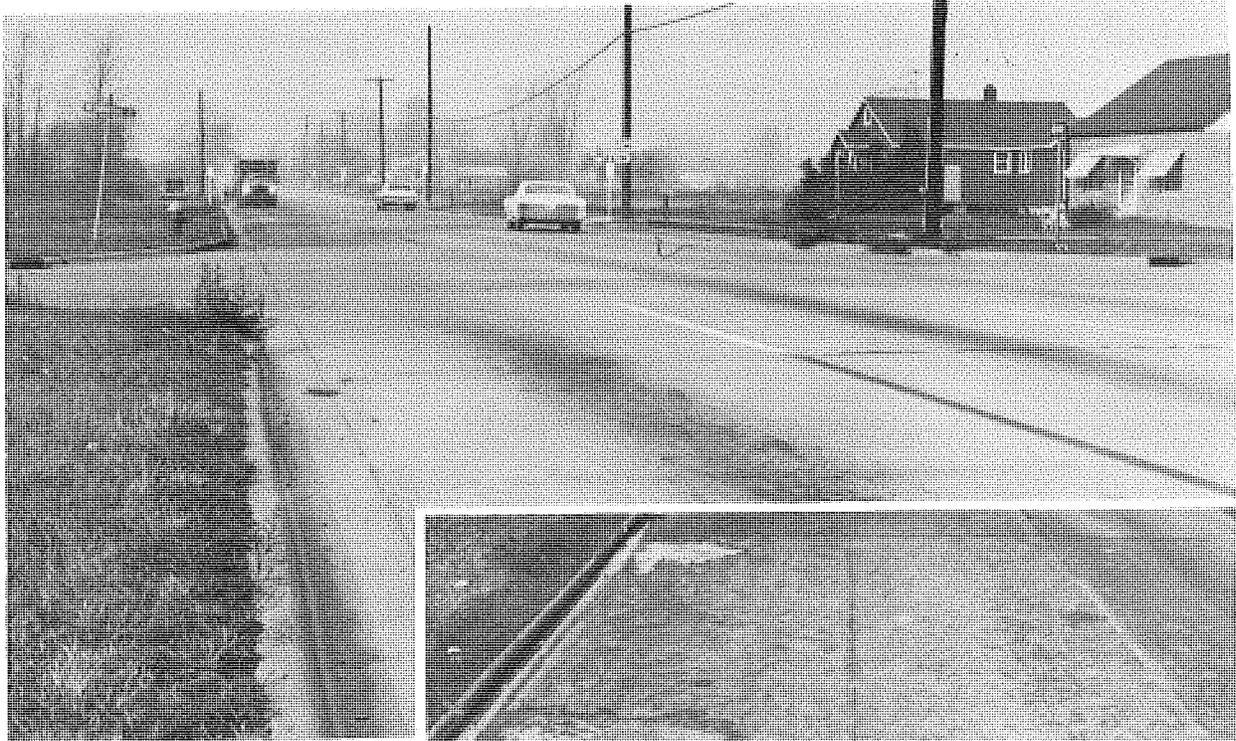


Figure 1. Westbound M 20 roadway damaged by fire in the city of Midland.



▲ General view of fire area looking west.

Western limit of damaged area; looking west from Sta. 110+10. ▶



◀ Close-up view of most heavily scaled portion (Sta. 112+75).

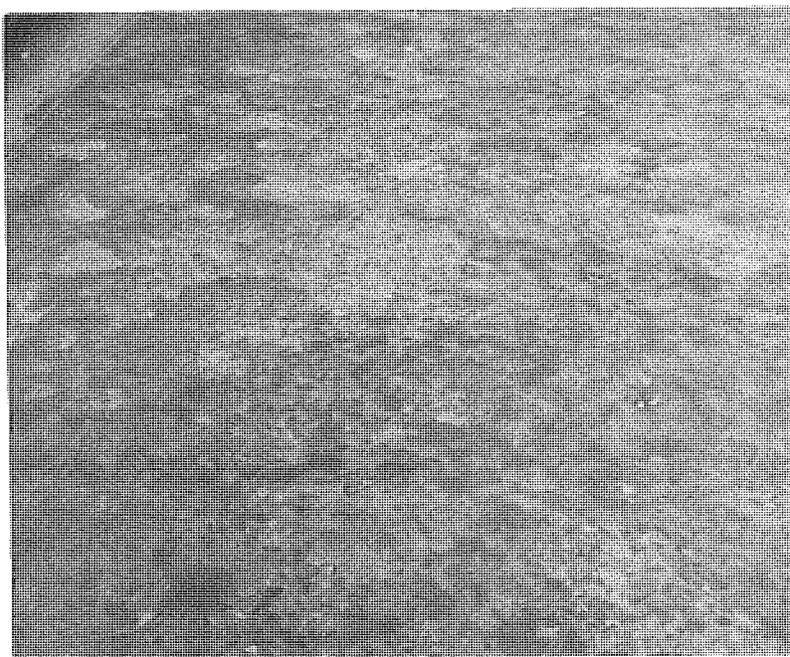


Figure 2. Fire damaged area on westbound M 20, city of Midland.



Figure 3. Condition of pavement at Sta. 112+37 showing close-up view where core No. 5 was taken (above) and an oblique view of a sawed cross-sectional slice from the core (below). Note darkened mortar strip at the top surface where intense heat drove hydrated water from the cement.

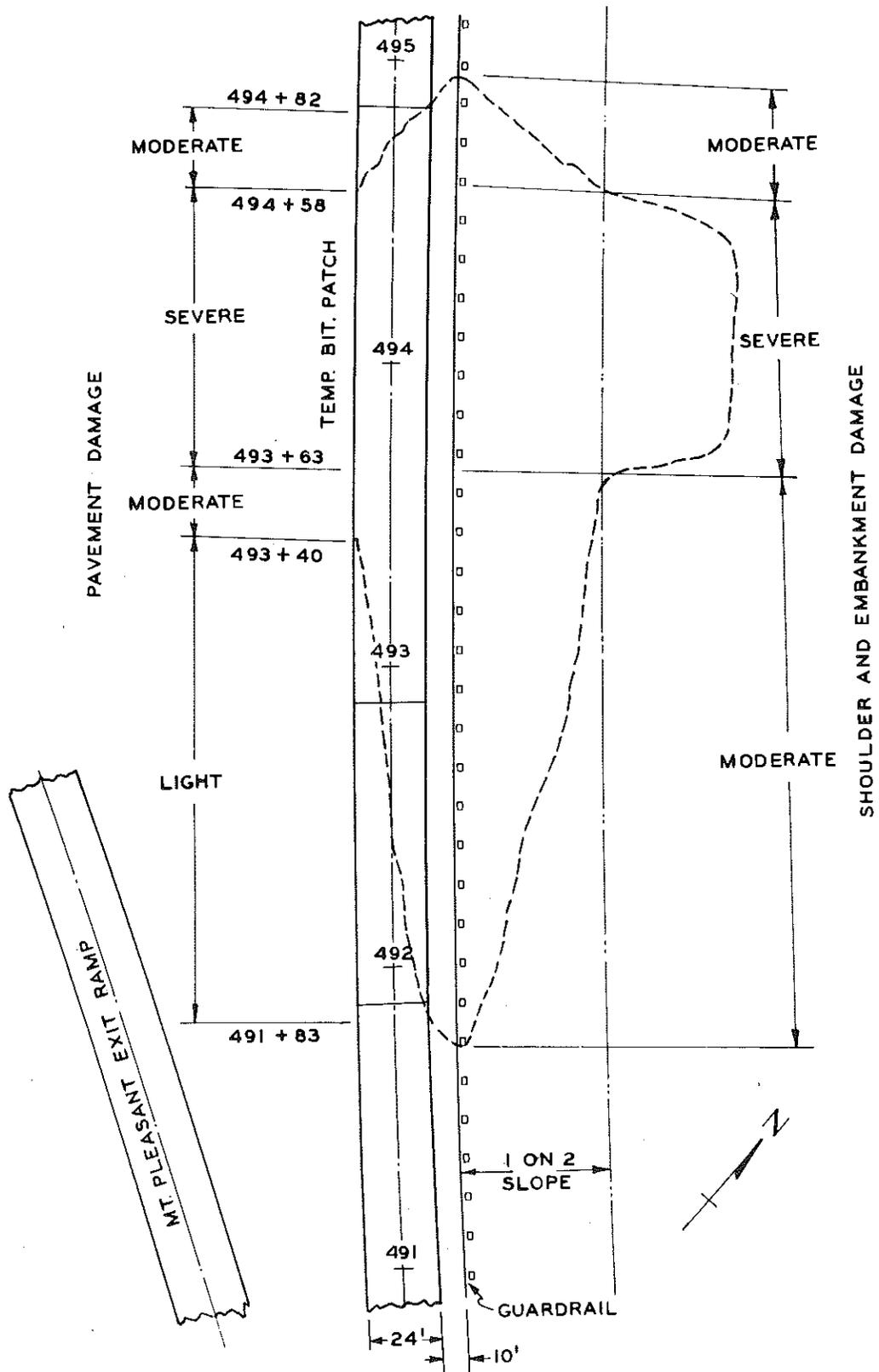
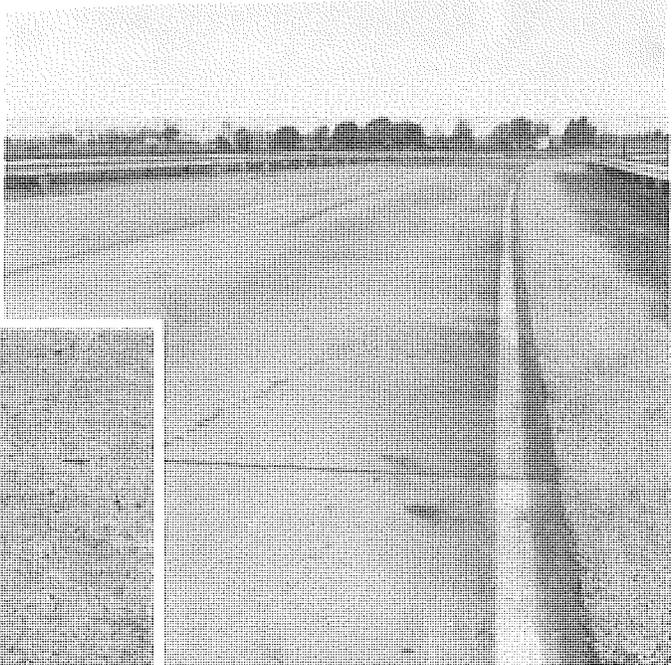


Figure 4. Northbound US 27 roadway damaged by fire near Mt. Pleasant

View of damaged pavement looking northwest from Sta. 491+80.



Close-up view of moderately damaged area northwest of patch. Note craze or shrinkage cracks resulting from the high temperature.

View of area looking northwest from patched area to moderately damaged area in background.



Figure 5. Fire damaged area on US 27, south of Mt. Pleasant.