OFFICE MEMORANDUM

MICHIGAN

DEPARTMENT OF STATE HIGHWAYS

June 27, 1973

To: Lowell J. Doyle
Traffic and Safety Division

From: Max N. Clyde

Subject: Failure of Preformed Guy-Grip Dead-Ends Used for Suspending Steel Cable from Poles.
Research Project 73 TI-159. Research Report No. R-866.

Recently the Traffic and Safety Division has experienced at least six incidences of failure in preformed guy-grip dead-ends which support signs and traffic signals over the roadway. The dead-ends that are failing have only been in service for about four months. One of these failures occurred on M 99 (Logan St) in Lansing. The guy-grip dead-ends from this installation were removed and delivered to the Research Laboratory Section for analysis. Figure 1 shows the break in this dead-end which failed at the loop holder. Figure 2 shows the dead-end at the opposite end of the same cable which had two broken strands at the loop holder. The appearance of the breaks indicates that the wire is very brittle and does not have the ductile properties that it should possess for this type of loading condition. The ductility of a metal refers to its ability to undergo a plastic deformation without fracturing. The loading applied to the dead-end is the weight of the cable and the sign or traffic signal plus the cyclic wind load which causes the dead-end loops to wear back and forth in the loop holders (Fig. 3). As the wire strands wear in the loop holder, small deformities become stress concentrations where localized plastic deformation must occur even though the loading has not been increased. A ductile wire can undergo plastic flow at these points without failure, but brittle wire will fracture under these circumstances. Even if the wire can meet the tensile loading requirements, if it does not have the proper ductility it will not withstand these service loading conditions. The appearance of the dead-end failure submitted indicated that this could be the problem.

To check the validity of this theory, the Research Laboratory tested to failure a series of the guy-grip dead-end cable holders. These dead-end specimens were pulled in tension using the loop holder that is employed in a typical field installation (Fig. 4). The dead-ends were loaded to their ultimate load capacity and the nature of the fracture was observed in the wire strands. Six new dead-ends, taken from warehouse stock, were tested and the ultimate loads ranged from 17,500 to 17,900 lb with a mean of 17,670 lb. The fractures of the individual strands were due to ductility failure as can be seen by the "necking down" of the wire cross-section at the break

(Fig. 5). Six dead-ends that were installed with the four-month old group in question were brought in from field installations and tested. Their ultimate loads ranged from 13,200 to 17,600 lb with a mean of 16,160 lb. Significantly every strand fracture from this group had a brittle appearance with no signs of "necking" at the break (Fig. 6). As a further control, two dead-ends from a field installation that has been up for eight years were tested. The ultimate loads were 17,500 and 18,500 lb and the wire fractures were ductile with "necking down" of the cross-section at the breaking point. The 3/8-in. steel cable held by these guy-grip dead-ends has a rated capacity of 10,800 lb. All dead-ends tested exceeded this load but the fracture appearance shows a lack of ductility in the four month group.

It is our understanding that after this four-month old stock of dead-ends had been in use for several months, the warehouse returned the remainder in stock to the manufacturer. This action was taken due to several incidences where the dead-ends failed to grip the cable properly and some installations fell during erection. This further indicates that the dead-ends experienced a fault somewhere in the manufacturing.

On the basis of these tests it is concluded that the guy-grip dead-ends installed with the four-month old group lack the wire ductility necessary to sustain the required service loading conditions. As the dead-end loops wear in the loop holders the problem could become even more acute. Since the location of these possible failures is a menace to public life and property, it is recommended that all the dead-ends which belong to this four-month old group be located and replaced as soon as possible. It is our understanding that these dead-ends were distributed to the Traffic and Safety Division's Electrical Devices Unit, Overhead Sign Unit, and District Maintenance Electricians. In addition, distribution may extend to the City of Lansing, the Lansing Board of Water and Light, Genesee County, Wayne County and other possible agencies as shown by Traffic and Safety Division records.

As to continued use of the guy-grip dead-ends, our own service record shows that they are economical and reliable as long as the materials used in their manufacture have the required strength and ductility properties. It is recommended that the currently used loop holder (Fig. 3) be discontinued and that the loop holder shown in Figure 7 be used exclusively. This arrangement will minimize the wear placed on the dead-end's strands themselves and greatly reduce the possibility of a recurrence of the problem at hand.

TESTING AND RESEARCH DIVISION

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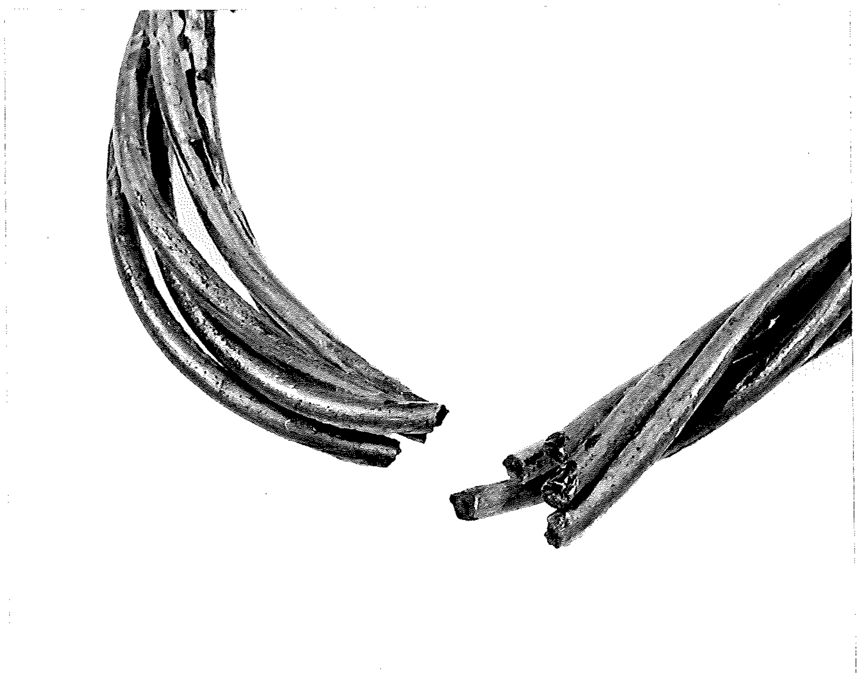


Figure 1. In-service failure of guy-grip dead-end at the loop from a four-month old installation.

Figure 2. Two failed strands on the dead-end installed opposite the one in Figure 1.

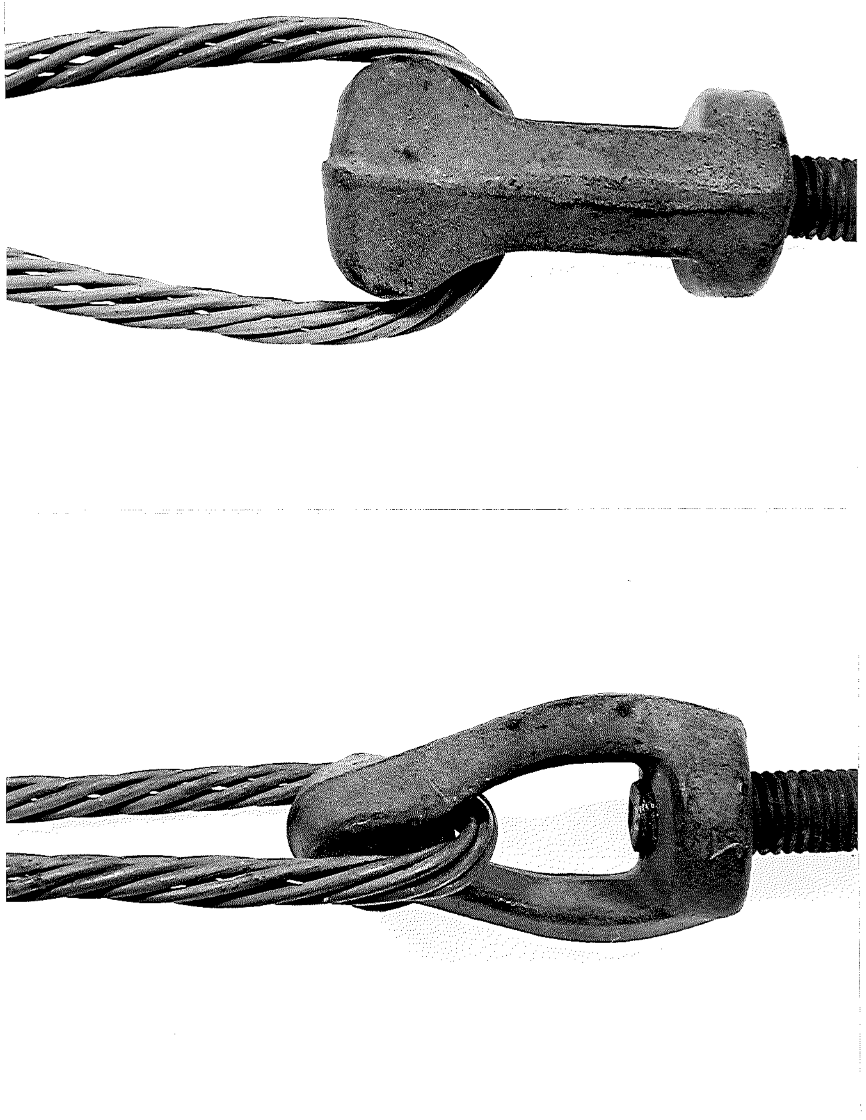
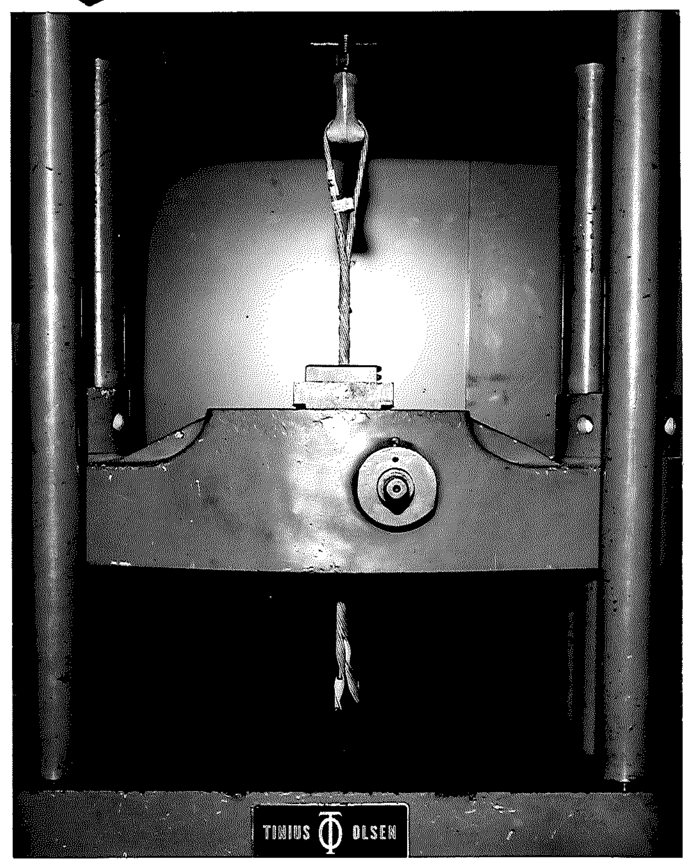


Figure 3. Loop holder currently employed in field installation of guy-grip dead-ends.

Figure 4. Tension test on guy-grip dead-end to measure ultimate load capacity.



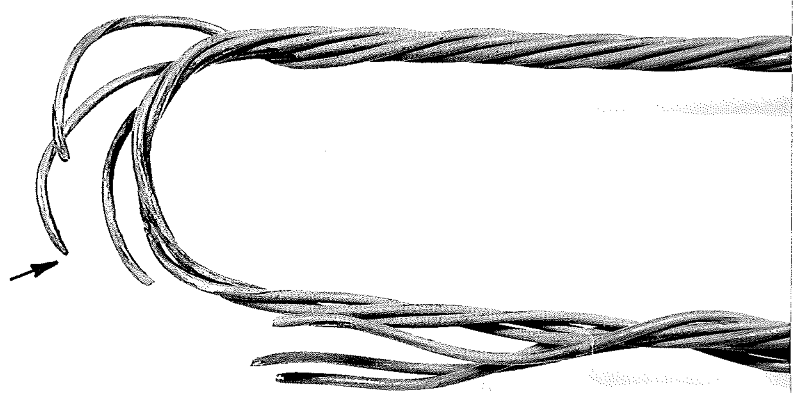


Figure 5. Failure appearance of guy-grip dead-end taken from new warehouse stock. Note the ductile necking down of the wire cross sections at the break.

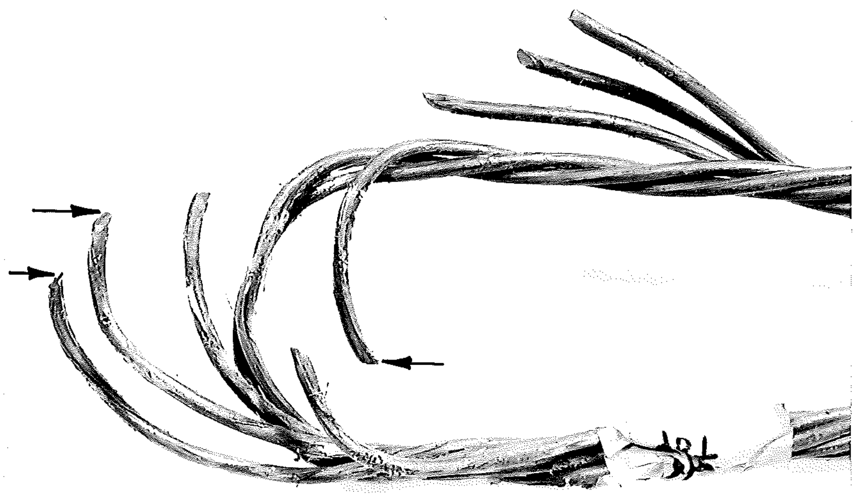


Figure 6. Failure appearance of guy-grip dead-end taken from a four-month old field installation. Note the brittle appearance of the fracture and the absence of necking at the break.

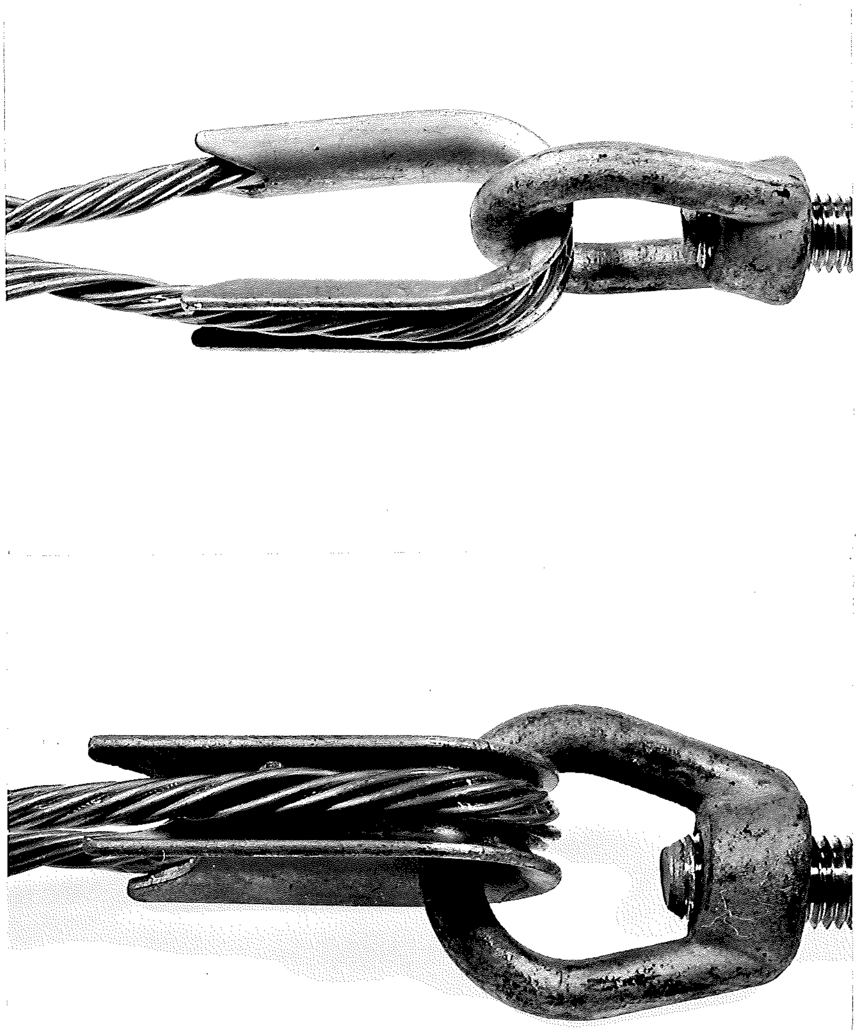


Figure 7. Recommended loop holder arrangement for guy-grip dead-ends to minimize wear on the wire strands.