MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 21-442 (project 563) | November 2021

Optimized Adhesive Performance in Electronic Transportation Sign Construction

the ISSUE

Dynamic message signs (DMSs) provide drivers with key traffic information. New DMSs are built using adhesive or chemical bonding rather than welding to connect components to reduce costs, provide uniform load distribution, and improve fabrication efficiency. To reliably utilize DMSs constructed with adhesive bonding in the U.S. transportation system, comprehensive knowledge of structural behavior of DMSs subjected to ultimate and fatigue loads is needed.

the RESEARCH

In this project, researchers examined the mechanical properties of adhesives used in DMSs under varying environmental and geometrical conditions and investigated the structural performance of full-sized DMSs with adhesive and welded connections. Adhesive tensile, shear, peel, and cleavage specimens with different widths were tested according to the American Society for Testing and Materials standards after conditioning them in different temperature and humidity conditions. Ultimate strength and fatigue tests were additionally conducted on four full-sized DMSs to determine the structural performance of adhesive and welded DMSs. For the ultimate testing, monotonic loadings were applied to each of the DMSs by a hydraulic actuator under the displacement-based control until failure. For the fatigue testing, each DMS was loaded up to 500,000 cycles with a constant force of 0.818 kN equivalent to design the natural wind gust pressure based on a yearly mean speed of 18.02 km/hr, according to the American Association of State Highway and Transportation Officials (AASHTO) specifications for structural supports for highway signs, luminaires, and traffic signals.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

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North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

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Project Title

Optimized Adhesive Performance in Electronic Transportation Sign Construction

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the **FINDINGS**

The average tensile stress of 16.94 MPa was found from the tensile testing data. For the shear tests, the average shear stress of 16.40 MPa was observed. From peel testing data, the average peel strength was found to be 6.63 N/mm, while the average cleavage strength of 196.61 N/mm was observed from the cleavage testing data. The ultimate testing also demonstrated that the adhesive DMS failed at 123.41 kN with the peak deflection of 133.35 mm, while the welded DMS observed a maximum load of 153.46 kN at a deflection of 158.57 mm. During the fatigue load testing, all the stress ranges observed in each of the tested DMSs were found to be considerably below the threshold of the aluminum DMS panel. No damage was observed in either the adhesive or welded DMSs when subjected to the fatigue loading.

the **IMPACT**

The researchers will ensure the findings from load and fatigue tests can be transferred to transportation engineers. The findings will help existing DMS producers better design adhesive bonded DMSs at lower costs with higher efficiency instead of using the traditional DMSs with welded components that are produced at a higher cost using more complicated manufacturing processes.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1050

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.

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