Project Summary

Texas Department of Transportation

0-6394: Evaluation of Overweight Load Routing on Buried Utility Plant

Background

Overweight traffic movements can negatively affect pavement integrity and quality. However, it is less known to what degree buried utility facilities along and across the right of way are affected by these overweight loads, especially if the utility facility is aged, placed under an exception to the Texas Utility Accommodation Rules (UAR), and/or subjected to repetitive loads. Routing decisions for repetitive overweight loads may be determined without consideration of cumulative impacts to utility infrastructure, particularly municipally owned lines that could be aged, accommodated under an exception, or of substandard materials. Given the growth in volume in overweight load (particularly mid-heavy and superload) permits, the adequacy of the UAR is unknown.

For this project, researchers: (a) reviewed technical design and engineering requirements for utility accommodation in Texas, (b) assessed the potential impact of overweight loads on buried utilities, (c) reviewed the potential for a business process for TxDOT overweight routing coordination, (d) examined the potential for changes to TxDOT manuals, (e) assessed UAR adequacy to deal with overweight loads on buried utilities, and (f) provided recommended changes to the UAR.

What the Researchers Did

The research team reviewed technical design and engineering requirements for utility accommodation in Texas and summarized typical materials and standards used. The research team also reviewed design requirements for underground utility structures in the UAR and summarized the development of these rules over the past 30 years.

The research team reviewed the current TxDOT business process for overweight load permitting in Texas and analyzed a dataset of roughly three million oversize/overweight load transports in Texas between 2004 and 2009. Concurrently, the research team reached out to utility providers and other utility stakeholders for cases of damages to buried utilities caused by overweight loads. The research team conducted a sensitivity analysis and 2D finite element analysis to assess potential damages to buried utility structures caused by static loads using data from the oversize/overweight permit dataset and standards provided in the UAR.

Following the sensitivity analysis, the research team conducted laboratory testing to assess potential damages to buried utilities caused by repetitive loading in conjunction with 3D finite element analyses. In the laboratory, the research team conducted static and fatigue loading tests on both jointed and unjointed PVC pipe, and jointed concrete pipe.

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What They Found

The outreach to utility stakeholders in Texas did not identify a case of damage to a buried utility potentially caused by overweight loads. The sensitivity and finite element analyses concluded that critical factors for buried utilities are axle positions, axle loads, backfill compaction, and depth of cover. For a critical condition using 7 axles of 48 kips per axle at a 95 percent compaction backfill and unpaved surface, the analysis found that a minimum of 1 ft depth of cover is required to satisfy a maximum pipe deflection of 5 percent or less for unjointed PVC and concrete pipe using static loading conditions.

Laboratory testing of jointed and unjointed PVC pipes and jointed concrete pipe found that repeated loading of 24 kips (HS-30 load) with 18 in. depth of cover at approximately 95 percent compaction of backfill induced a pipe deflection below the maximum of 5 percent for the pipe specimens tested. However, visual inspection of the concrete pipe after fatigue testing found a crack at the joint. Researchers hypothesized that the crack was a result of pipe bedding settlement and support of the pipe by the testing box at both ends, restraining the pipe ends from moving vertically while permitting vertical displacements along the length of the pipe. Subsequent analysis of this condition using 3D finite element software showed significantly higher displacements and stress sufficient to cause cracking of the pipe precisely in the location where the crack occurred during laboratory testing.

What This Means

The result of the testing and the lack of cases with damaged utilities from the outreach effort provide evidence that TxDOT should continue its current business process to share information on critical buried utility infrastructure as this information becomes available. With the implementation of the new Texas Permit Routing Optimization System (TxPROS), information about critical buried utility infrastructure could be included as a segment restriction or impedance.

Findings from the sensitivity analysis, finite element analysis, and laboratory testing indicate that the current standards provided in the UAR for water and sanitary sewer appear to be adequate to protect commonly used PVC and concrete pipe from repeat overweight loads. Therefore, the research team recommends maintaining the current standards provided in the UAR. To improve consistency and clarity, the researchers recommend several minor changes to the UAR in the area of depth of cover and encasement requirements. The recommendations include depth of cover requirements for certain types of water lines, and a clarification of the minimum depth of cover for encased sanitary sewer lines and underground communication lines.

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